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ENVIRONMENTAL IMPACT ASSESSMENT IN THE NORTH—Proceedings of the Technology Transfer Workshop

ÉVALUATION DES RÉPERCUSSIONS ENVIRONNEMENTALES DANS LE NORD—Comptes rendus de l'atelier sur l'échange d'informations d'ordre technologique

TECHNICAL WORKSHOP SERIES NO. 1
ÉTUDE Nº 1. SÉRIE DES ATELIERS TECHNIQUES

INLAND WATERS DIRECTORATE,
OTTAWA, CANADA, 1979

DIRECTION GÉNÉRALE DES EAUX INTÉRIEURES,
OTTAWA, CANADA, 1979

PROCEEDINGS*
of the
TECHNOLOGY TRANSFER WORKSHOP

ENVIRONMENTAL IMPACT ASSESSMENT IN THE NORTH

October 31, November 1-2, 1978

TECHNICAL WORKSHOP SERIES No. 1

COMPTES RENDUS**
de
L'ATELIER SUR L'ÉCHANGE D'INFORMATIONS D'ORDRE TECHNOLOGIQUE

ÉVALUATION DES RÉPERCUSSIONS ENVIRONNEMENTALES DANS LE NORD

Du 31 octobre au 2 novembre 1978

ÉTUDE No. 1, SÉRIE DES ATELIERS TECHNIQUES

*These papers reflect the views of the authors and are not necessarily those of the department.

**Ces documents contiennent l'opinion des auteurs qui ne correspond pas nécessairement à celui du ministère.

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FOREWORD

It will be immediately apparent that the following statements were written subsequent to the workshop. They comment on several aspects of the assessment of environmental impacts from northern development and the role of IWD.

One role, which was perceived to be the workshop direction by WSC, was to describe field and office techniques, instrumentation and procedures used in the AIPP investigations. The intent was to share this knowledge with other agencies and offices and to stimulate discussion from other groups with similar experiences. The ultimate outcome of this sharing of technology would be improved techniques of data collection necessary to assess environmental impact statements adequately.

A second view was that the workshop would address the problems of coordination between operational groups and research organizations within DFE. Put simply, the line managers at the workshop from the operational segment would identify data requirements which they could not address. The research groups would examine this "shopping list" and indicate what they could do to supply essential data.

It became evident during the workshop that one of the problems of assessment is the interchange of data between private and public sector researchers for common areas of interest.

Finally, some of the workshop activities provided instruction for preparing assessments of environmental impact.

Altered perceptions of data requirements for EIS assessments in Phase I of the EAR process were probably the single most significant result of the workshop for Winnipeg WSC staff, although it is still not too clear just when the more extensive data collection required for writing "terms and conditions" would be initiated. This aspect is crucial to hydrologic understanding which requires that representative samples of pertinent time series be made -- a process not normally possible in periods smaller than ten years.

The proceedings are in two parts: Part I contains summaries (in both French and English) of individual presentations and the ensuing discussion. Part II is a compilation of papers submitted by speakers in the language of presentation only.

AVANT-PROPOS

Il va sans dire que les remarques qui suivent ont été formulées après la tenue de l'atelier. Elles résument divers aspects du lien qui existent entre les répercussions environnementales de l'aménagement du Nord canadien et les apports de la DGEI à leur évaluation.

L'une des perspectives de l'atelier, dans l'optique de la DRHC, était de décrire les techniques utilisées sur le terrain et au bureau, les instruments de travail de même que les procédures d'enquête du PPIA. L'objectif était d'échanger des informations avec les autres organismes et bureaux et d'encourager les discussions entre les différents groupes afin de tirer avantage de leurs connaissances actuelles. Cet échange de renseignements techniques devrait permettre d'améliorer les modes d'acquisition des données nécessaires à une juste évaluation des répercussions environnementales.

Selon une deuxième perspective, l'atelier devait porter sur les problèmes de coordination existants entre les groupes de travail et les chercheurs au sein du MPE. En termes simples, les dirigeants des groupes de travail devaient dresser un inventaire des données dont ils avaient besoin, lequel était ensuite examiné par les chercheurs qui recommandaient de quelle façon procéder dans l'acquisition des données appropriées.

En troisième lieu, l'atelier devait se pencher sur le problème de la dissémination des données de nature à intéresser les chercheurs des secteurs privé et public oeuvrant dans des domaines connexes.

Enfin, certaines des activités de l'atelier avaient pour préoccupation de fournir les instructions nécessaires à la préparation des évaluations des répercussions environnementales.

Le principal résultat de l'atelier quant au personnel de la DRHC de Winnipeg, était probablement le nouveau point de vue adopté dans le domaine des besoins en données pour les énoncés initiaux des répercussions environnementales, première phase de PERE. Il n'est pas encore clair toutefois quand un programme de cette envergure sera mis sur pied pour rassembler les données nécessaires à la rédaction des <<modalités et conditions>>. Ce facteur revêt une importance primordiale sur le plan hydrologique puisque les échantillons doivent être représentatifs d'une série temporelle particulière, c'est-à-dire que les observations ne doivent pas normalement s'échelonner sur des périodes de moins de 10 ans.

Les comptes rendus renferment deux parties: Partie 1 - résumés (en anglais et en français) des documents présentés et des discussions et Partie 2 - documents de base soumis par les participants dans leur langue maternelle.

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PART I

ABSTRACTS AND DISCUSSION SUMMARIES

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Session 1

ENVIRONMENTAL IMPACT ASSESSMENT IN THE NORTH

J.E. Slater

Abstract

Sound environmental impact assessments can be made only from an extensive data base. We must be able to describe antecedent conditions; our concerns are hydrologic, atmospheric, geologic, biotic, aesthetic and the pre-development level of land and water use. Sufficient data should exist to predict altered conditions resulting from development and to suggest remedial measures for identified impacts. Constraints of finances, manpower, time, politics and technology are not mutually exclusive and act together to prevent the collection of data in the North. Our findings, especially in hydrology, are therefore much more subjective than is scientifically acceptable. Hydrologists must therefore be exceedingly careful to select the most significant sites, to sample the right parameters and to time their sampling properly. In the next few days, we will examine the experiences of several groups who have engaged in this process in northern Canada.

Discussion

None.

SESSION 2 - AIPP SLIDE PRESENTATION

J.G. Way

Abstract

This audio-visual session consists of a series of 25 to 30 transparencies supplemented by descriptive commentary. The slides have been selected from the hundreds of available photographs taken during the AIPP hydrologic regimes studies from 1975 to 1977 inclusive. The slides serve to illustrate river forms, river processes and terrain land forms within the proposed Polar Gas pipeline corridor. Slides of riverine instabilities and of geomorphic activity thought to have a bearing on pipeline design, construction and maintenance constitute most of this presentation.

The slide presentation has been arranged in a geographic (i.e., south-to-north) rather than temporal order to illustrate the transition from the boreal forest of southern District of Keewatin to the wetland sedge meadows and barren uplands of the central Queen Elizabeth Islands. This presentation will serve as an introduction to subsequent sessions.

The slides being shown form a basis for the production of a 100-slide audio-visual package of IWD's involvement in the Arctic Islands Pipeline Program presently being prepared by Water Planning & Management in Regina.

Discussion Summary

In the central Arctic Islands there are only two hydrometric stations that collect regular water level and flow data. They have been in operation on a seasonal basis since 1972. They both are located near the supply centre of Resolute to reduce costs. During the study there was no specific project looking for groundwater intrusions into the rivers, but it was observed that on those rivers that froze solid during the winter, the permafrost remained through the summer only a metre or so below the riverbed.

In the southern Arctic, i.e., central and southern Keewatin District, there can be 100% ground cover but the Central Islands are generally barren due to high concentrations of carbonates in the soil. Most of the vegetation is found in sheltered valleys, some of which could be termed arctic oases, e.g., Polar Bear Pass on Bathurst Island.

Although there is little substantiating data, sedimentation rates in the Arctic are considered to be low on an annual basis, but peak rates at spring flood or after late summer rains may be quite high.

The study sites were selected to be near the principal and alternate pipeline routes, but were also to be representative of the regions through which the pipeline passed. Preliminary findings were considered by the proponent so that he could adjust his proposed route and drop alternatives.

The method of describing rivers in terms of the related geomorphic processes is quite effective. This procedure has not been included in regular programs by Winnipeg Water Survey of Canada, although it is planned to initiate such data collection north of 60° in conjunction with routine activity.

Session 3

THE ARCTIC ISLANDS PIPELINE PROJECT: Its Goals, Objectives and Program Development for Freshwater Project No. 1

J.E. Slater

Abstract

The terms of reference supplied to our study group directed us to examine the effects of a buried gas pipeline on river crossings. Because of provincial jurisdiction, our study was confined to regions north of 60° latitude. We sought to find answers to two questions:

1. In what way will construction and operation of a pipeline affect the hydrologic environment as related to rivers and lakes along the route?

2. What aspects of fluvial morphology and hydrology will affect the design, construction and safe operation of such a pipeline?

The principal constraints on the study were time and money. The time period of 2-3 years made available to us was insufficient to obtain data for hydrologic and geomorphic parameters in the usual way which normally relies on statistical analysis for sampling periods in excess of 10 years.

The absence of any hydrologic network north from the Keewatin District (one station on Cornwallis Island) made data transfer techniques untenable. What we were able to do was provide a qualitative description of river features based on map studies, airphoto analysis, and spot sampling of pertinent parameters at 27 selected river sites visited on two reconnaissance surveys. Sampling information, later assembled in a stream catalogue, described streamflow, sediment concentration, bed and bank material, ground-ice conditions, floodplain characteristics, river slope and valley-wall approaches.

Aside from their value to us, the data assisted researchers in associated disciplines. Not very much hard data resulted from these studies, but examination of fluvio-morphologic processes active in the barrenland permafrost regions permitted the tentative definition of some areas thought to be environmentally sensitive to pipeline activity.

Discussion Summary

For the route south of 60°, very little additional work was done by government agencies although the pipeline consultants performed some basic research.

North of 60° latitude, the consultants and ourselves exchanged data in order to avoid excessive duplication of research and baseline data collection. They directed their field studies to sample parameters not addressed by us, such as drilling programs to sample ground temperatures and materials in river valleys. Map studies, prior to field undertakings, were considered to be essential. Several route changes and modifications to original plans have resulted from the preliminary studies, e.g., re-routing on Bathurst Island around Polar Bear Pass, an eastward re-routing in the Rasmussen Lowlands south of Spence Bay, and a change in the vicinity of Stanwell-Fletcher Lake on Somerset Island.

In the hydrologic sense, the three chief design changes resulting from studies were overhead crossings at Thelon and Tha-Anne rivers and new crossing selection on the Kazan River.

The third year proposal, an inter-agency study in applied research which proposed to manipulate natural conditions at a river crossing in a well-instrumented small watershed, was not funded.

SESSION 4 - WATER-RELATED ENVIRONMENTAL FACTORS

R.J. Lane

Abstract

Costly, accelerated response by government to northern development is obsolete today. IWD and DFE policy relating to northern environmental assessment is still evolving, but it is clear that IWD has responsibilities in this process to provide advice to an Initiator's development of an Initial Environmental Evaluation (IEE), to provide staff to serve on Environmental Assessment Panels, to assist in the preparation of guidelines for Environmental Impact Statements (EIS), and to evaluate EIS reports.

No IWD studies are needed except when paid for by an Initiator or when IWD is incapable of providing sound advice. For water quantity, federal interests are interprovincial flows or international commitments, the latter including factors relating to waterfowl and climate. A change in flow trend because of development could also create an inventory concern. Concerns related to sister agencies in the North are flood damage, changes in navigable waters and threatened waterfowl or fish habitat. Pertinent water quality concerns are in interprovincial or international waters. In addition, contamination by toxic substances requires problem definition, as well as parameter sampling and predictive model evaluation. Other quality concerns are radioactivity, eutrophication, oil spills and waste heat disposal. Additional network development for impact assessments should be minimal and preferably cost-shared with provincial or territorial governments.

Discussion Summary

A lively discussion centred around increase in northern networks. It was agreed that severe network deficiencies exist in the District of Franklin. Some of the necessary expansion no doubt will be cost-shared with DINA. For new stations not so funded, a detailed, comprehensive submission must be prepared to pinpoint specific IWD concerns. It was suggested that one main IWD concern with a northern fuel transportation system involves the hundreds of small stream crossings. One solution would be to identify homogeneous hydrologic regions and then to select representative basins to define zonal parameters. Changeable government policies make it exceedingly difficult to establish increases in long-term baseline networks, and IWD managers will be called upon to exercise their ingenuity to obtain maximum data return from money and manpower available.

SESSION 5 - ASPECTS OF DRAINAGE BASIN MORPHOLOGY OF RELEVANCE TO ARCTIC HYDROLOGY

Dr. W. Rannie

Abstract

In regions of very little precise data on streamflow and sediment regimes, study of basin properties has relevance for comparative studies within or between regions. The basin properties especially relevant to arctic hydrology are basin aspect, relief, relief distribution, drainage density, drainage area, area of lakes and glacial history. Morphology is also used to prepare prediction equations. Basin aspect helps to explain variations in thermal latitude of a basin, depth of active layer, vegetation, precipitation and snow distribution. Relief, in a crude way, defines potential energy gradients and thus becomes an input into runoff and sediment yield models. Relief distribution relates to climatic variables sensitive to elevation such as precipitation, temperature and condensation. Drainage density analysis provides a better understanding of the sediment transport system on hill slopes and the water transport system within rivers, and the dynamic equilibrium which exists between the two systems.

The role of thaw lakes and closed depressions makes the calculation of drainage area, which is hydrologically significant, quite difficult. It is a most useful assessment parameter, since it correlates with mean annual flood, mean annual runoff, maximum flood, daily peak flow and unit sediment yield. The presence of large or numerous lakes in a drainage basin would prevent accurate assessment of regional hydromorphologic parameters. The concept of paraglaciation, which postulates higher-than-normal sediment yields in recently deglaciated basins, should be considered in regional analysis for areas such as the Arctic. A sediment-yield equation based on morphologic parameters is presented which appears to have merit for preliminary evaluation of regional sediment transport rates.

Finally, it is noted that arctic basins have a number of features in common with urban and semi-arid basins. A review of available models might provide useful data to northern programs.

Discussion Summary

There are a significant number of days at the Resolute weather station that are given "trace" amounts of precipitation for the day , or less than 0.01 inch of precipitation. By looking at the total amount of summer precipitation, it becomes readily apparent that a good portion of the recorded precipitation in summer is measured in trace amounts. The errors of accuracy in such a system are obvious. Where there are

areas of very low rainfall, even small errors of measurement are significant. Since evaporation is normally determined as a residual in the water budget, our notions about evaporation are also affected. Many drainage basins in the North contain large portions that do not have an integrated drainage pattern. In addition, the lower parts of many of the arctic streams are highly braided, presenting problems when looking at drainage densities. Has the morphology analysis been able to cope with these kinds of problems? Not really; most morphometric studies which have been successfully related to hydrologic studies have been conducted in "classic" or well-defined drainage basins. Therefore, drainage density in the Arctic is not very useful where areas of extreme braiding occur.

In areas of continuous permafrost, modelling is made much simpler. It becomes a matter of taking the snowmelt and routing it over the surface. Arctic systems are among the simpler types of runoff systems even if data is difficult to get. It would certainly be easier to analyse than a normal, agricultural or forested watershed.

SESSION 6 - ASPECTS OF RIVER MORPHOLOGY

Dr. R.W. Newbury

Abstract

Central to the writer's view of river morphology is a concept of fitness—a concept most difficult to describe since it cannot be defined precisely, but is still based in science.

Fitness in natural systems describes how one system fits with others, how well it blends into a unified whole. Environmental impacts are *deviations* from this natural "fit". Fitness of a river system can be described by examining the "random walk" development of drainage networks, which are analogous to other natural networks such as those of trees and blood vessels.

The ratios of branch order and branch length remain constant regardless of basin size. A second concept of fitness examines the vertical distribution in a river system and addresses a concept of stream power. It states that equal segments of river channel in unconsolidated materials generate equal amounts of power. In typical, upwardly concave profiles, the headwater segments have greater head but less water than lower segments. Natural river systems will work towards the re-establishment of this equilibrium when man introduces changes in the regime.

Two examples of misfit systems in northern Manitoba are the diversion of Churchill River into a headwater on the Nelson River, and the raising of Southern Indian Lake water levels. In a geologic time-frame, these perturbations are of no consequence, but in the short run of 50 to 100 years, a normal planning horizon for larger-scale development, they create rather severe environmental impact.

Discussion Summary

Although the two examples of misfit development create negative impact, this is not always the case; e.g., Niagara River. Examination of process as well as form leads to skillful development solutions with some positive impact, e.g., run-of-the-river power plants on the Churchill instead of diversion into the Nelson River. The prediction of impact of the latter development was fairly good for physical aspects, rather less good for biological factors and completely in error for sociological impact. The lower Churchill regime since diversion, a case of a small river in a large valley, is a unique alteration to a river system with new environmental impact problems such as icing and loss of fish spawning beds in drained lakes. These are problems not previously researched and little is known of their potential, long-term impact.

SESSION 7 - MORPHOMETRIC and HYDRAULIC DATA COLLECTION PROGRAMS

J.G. Way

Abstract

This talk describes data assembly techniques used in the Arctic Islands Pipeline Program. Site selection was by map and airphoto analysis, as was the assembly of data on chosen sites for stream order, hypsometric coefficients, integrals, basin area, river length, basin perimeter length and width. In the field, samples were obtained of suspended sediment, bed material, streamflow, water quality and thaw depth. Qualitative assessment of surrounding terrain was made on prepared forms. Hydraulic channel properties were measured. Subsequent analysis suggested possible flood magnitudes for studied sites.

To incorporate these procedures into our regular programs requires staff training.

Discussion Summary

The Pacific & Yukon Region, in a much shorter time period than the AIPP studies, produced a fairly detailed study describing three hydrologic aspects: streamflow, water quality and erosion-sedimentation. Streamflow aspects were examined by regression studies, by channel geometry analysis and by use of the kinematic wave model. Field programs and DPW Highways Data provided scour and sediment data. Some regime equations were developed. The Polar Gas studies attempted to use satellite imagery, but clouds prevented assembly of much useful data. It was suggested that aerial photo analysis of specific crossings might have provided much data at relatively low cost. Polar Gas investigators felt that only qualitative statements could be made of problems for specific crossings or terrain units. The pooling of data from all sources for regions with little or no information is the most cost-effective way of assembling data necessary to impact assessments.

SESSION 8 - A BIOLOGIST'S VIEW ON THE ROLE OF WATER CHEMISTRY IN ENVIRONMENTAL ASSESSMENT

E.K. Langtry

Abstract

Water chemistry is important for environmental assessment purposes, but traditional studies have often failed to assist in impact predictions. Biological analysis by itself does not define water quality precisely and should be correlated with water chemistry.

The variability in chemical data can be controlled and identified with suitable study schemes. Proper sample handling and analyses by trained chemical technicians will eliminate variance due to human error. The variability characteristic of natural waters, both temporally and spatially, can be accurately estimated by careful selection of sampling frequencies and good network design. Chemical studies will achieve their maximum value when they are integrated with research in other environmental disciplines.

A thorough understanding of ecological processes can be gained through intensive research on selected aquatic systems, rather than by reconnaissance type inventorying. The predictive capability that will be generated from modelling exercises will improve the quality of environmental impact evaluations.

Discussion Summary

Water quality, commonly thought of as synonymous with water chemistry, is in reality an assessment of the entire aquatic environment and measures physical, chemical, biological and sedimentological parameters. We require system data and have to look at processes involved—not just inventory. The study of complex ecosystems and the monitoring of change within them is complicated further by administrative and conceptual constraints, e.g., AIPP studies funding for limnology and water quality studies were difficult to obtain from management. The scientific community must not only be excellent scientists in this era of fiscal restraint—they must be good salesmen. The most cost-effective method of data collection would be representative system analysis, i.e., let the proponent gather inventory data and government conduct site-intensive studies. Process studies at carefully selected representative sites should be paramount. Arctic biological parameters are vital, and short-term biological changes are often missed by infrequent visits—an example of this comes from two site-intensive studies on the Alaska Highway which identified severe oxygen deficiencies in ice-covered waters and resulted in microbiological studies to identify oxygen demand under ice. It is likely this entire phenomenon would have been missed in routine visits. The integrated approach to field surveys is functional in the Atlantic Region and to some degree in Western & Northern Region.

SESSION 9 - BASIN STUDY: BATHURST ISLAND, 1976

J.H. Wedel

Abstract

An intensive basin study on western Bathurst Island was undertaken in Year Two of the Arctic Islands Pipeline Study. The basin was situated in a region of fairly uncohesive soils and little previous hydrologic data. The field program assembled meteorologic, hydrologic and sediment data for the runoff period in 1976. Subsequent analysis produced an empirical relation of runoff derived from Resolute Bay precipitation data, some mathematical models describing snowmelt, streamflow and sediment discharges, and values in a water budget for the basin. The results indicated that annual runoff and sedimentation rates were greater than those shown in the current Hydrologic Atlas.

Discussion Summary

Site selection was based on terrain sensitivity identified in 1975. A better site in terms of higher sediment yield and mass movement phenomena could probably have been located in the siltstone and shale deposits of the Eids outcroppings 25 miles to the east, or to a site on eastern Melville Island. These locations were not used because of proximity to the IBP program in Polar Bear Pass in the first case and logistic costs in the second.

The study data indicate an inconsistency with information in the Hydrologic Atlas. Both runoff and sediment yield were found to be greater than those shown on atlas maps. Clearly, the data base for these parameters is inadequate for the Arctic Islands, and there is no differentiation between relatively poor data in the north and good data from the south on these maps. The use of the Nipher snow gauge on the barren lands consistently undervalues snow precipitation. In the Resolute Bay region, comparison of snow survey results and Nipher gauge catches suggests an undercatch by a factor of two. Snow sublimation is an important constituent of a northern water budget, although its inclusion in an annual water budget can be avoided if snow-water contents are measured just prior to runoff and after the high insolation periods of May and June, when much of the sublimation occurs. Evaporation, condensation and trace precipitation can be thought of as residuals which tend to cancel one another out.

SESSION 10A - A DISCUSSION ON SNOWMELT

P. Baracos

Abstract

Runoff generated from snowmelt constitutes the bulk of yearly flow in the North. Prediction of runoff volumes and their temporal distribution can be obtained from measurements of snow quantity and by modeling melt processes. Such predictions are important to water-related developments, to environmental impact assessment, to estimated missing hydrometric data and to extend existing records.

AES snow gauges undercatch snowfall in the barren lands and the relocation of snow by drifting is not addressed. Snow surveys, prior to runoff, supply accurate water content data provided that snow courses are designed to sample basin terrain units in a representative way. Snowmelt models may be explicit or implicit and based on meteorologic parameters in a heat balance model or be based on empirical, simple regression models tailored to fit site-specific parameters. Stochastic model development should consist of three stages: 1) identifying the best model type, 2) estimating model parameters and 3) diagnostic checking. New computer programs make the 3-stage process quite straightforward. Intervention analysis by means of stochastic models promises to be a most useful tool in impact assessment. A transfer-function model relating runoff time series to precipitation and temperature is currently under development for the implicit modelling of snowmelt. The Akaike Information Criterion provides a useful, unbiased criterion for model selection. The criterion considers goodness of statistical fit and model simplicity.

Discussion Summary

Models are most useful as predictors of unusual events such as floods. The Box-Jenkins model could have described snowmelt more precisely than the ones which were used for Snowbird Creek. Hydrologic data levels in the Arctic are just now approaching minimum levels useful in modelling; 17 stations now have 10 years of data. The use of intervention analysis models to assess environmental impact is equally important after development has occurred, so that impacts can be measured precisely. This says that data should be assembled before, during and after develment so that the natural-state baseline parameters can be used to measure against. In the case of the Reed Paper Co., it could not be established in court what baseline Hg contamination levels were prior to development. Consequently, it could not be proven that the paper plant contributed to contamination. Traditional statistics demand that data variables be independent. Since much of the test data here was auto-correlation classical tests could not be used. Auto-regressive techniques remove the correlation and allow traditional tests to be made on residuals, so that confidence limits for data can be established. This sort of analysis should be useful to assess impact after it has occurred.

SESSION 10 B - SIMULATION OF RUNOFF: FALLS RIVER, ELLESMERE ISLAND, N.W.T.

D.C. Ambler

Abstract

In 1973, the Frozen Sea Research Group, FMS, Victoria, identified a requirement for estimates of freshwater input into the waters of d'Iberville Fiord. WSC, Halifax, was asked to develop this data for a three-year program to run from 1973 to 1975. A small basin was examined near the base camp at 80° 37' N. and 79° 45' W. In conjunction with a normal stream-gauging program on the Falls River basin measuring 29.5 km^2, the watershed subroutine of the SSAR Model was developed to fit basin data parameters. Development of runoff simulation models based on snowmelt and rainfall input data for permafrost regions is of high priority so that first estimates of hydrologic impact of new northern developments can be made. The input requirements for the developed model consist of non-variable physical parameters, initial hydrologic condition data and time variable data such as precipitation, air temperature and snowmelt. In order for the model design to simulate low flows in late summer recession, it was necessary to incorporate groundwater flow components, which does not appear rational for a basin underlain by permafrost. This is likely necessary because of the initial assumptions incorporated in the simulation. Even though this first run does not predict daily flow events precisely, the technique holds great promise for future use in northern Canada.

Discussion Summary

It was not thought that increased temporary storage behind snow dams seriously affected the runoff pattern on Falls River. The initial simulation did not produce as good results as had been hoped. Error analysis of input data is necessary. A good simulation should generate data within 10% of measured data. This appears possible. The most sensitive parameter was the soil moisture index. Although extrapolation of this model to ungauged basins should be done with great care, it shows considerable promise of being able to provide sufficient hydrologic information for preparing and evaluating environmental assessments. It is not known presently how the model would respond to man-made perturbations on the physical basin parameters.

SESSION 11 - IWD DATA AND CONSULTANTS

C. Templeton

Abstract

The goal of Impact Assessment Process is to protect the environment. To achieve that goal there are four phases:

1. Help the decision maker in deciding if, where and how a project should proceed.
2. Set out terms and conditions so that impacts can be limited to those predicted.
3. Monitoring and surveillance of the project.
4. Post-construction evaluation.

The basic data needed for each of these phases is different.

The Impact Assessments of the proposed pipeline schemes from Prudhoe Bay and the Mackenzie Delta are reviewed with particular reference to the data needed and used for Phase I (the data needed to assist the decision maker).

A numerical comparison is made of the Mackenzie Pipeline route with that of the Alaska Highway and the "Water Component" discussed to show the relative importance of water to the other components in the ultimate decision.

The talk concludes with a discussion on who should provide basic data, how much is needed, and how professional opinions and conclusions should be presented in impact assessments.

Discussion Summary

Technology transfer between the public and private sectors has a good success record at the working level. Both sides would benefit from improved interchange at the policy-making and planning levels. The public sector has a better scientific organization and the two sides working together would optimize impact assessment. In the environmental impact assessment process, federal staff now appear on both sides of hearings, as proponents and panel members. Loss of credibility results. The extremely detailed terms and conditions in vogue today are of questionable merit. Indeed, they probably act as a deterrent to development, since perceptions and concerns change as the data base increases. In the decision-making process it is essential to present the total picture. The danger of such presentations is that they are almost completely subjective and therefore liable to misinterpretation. The description of salient points of concern can best be done with the use of well-illustrated pamphlets and reports. The importance of photographs to complement written material was demonstrated in the final Berger Report—a best seller.

SESSION 12 - FEARO PRESENTATION

P.G. Wolf

Topic Suggested

EAR Process, to be discussed in such a way as to include:

- information requirements, how they are determined, and how they are assigned to IWD
- how information required is included in environmental impact statements
- the effectiveness of IWD in this regard.

Also to be addressed:

- lessons learned to date
- how environmental impact assessment procedures could be improved

Plan

To explore these questions within the following topic headings:

1. The EAR Process.
   - to be discussed from a transparency of the process diagram
2. Where information requirements are generated within the process (process diagram slide).
3. Role distinction.
   - EARP
   - PANEL
   - FEAR OFFICE
   - D.O.E.
4. Roles of D.O.E. (IWD) staff in process.
   - transparency of a matrix giving inter-action

   (If time is short, this can be a hand-out before questions begin.)

ROLE

FUNCTION	REQUEST INITIATOR	INDIVIDUAL TECH. (EXPERT)	TASK FORCE	UNIT OF DEPT.	DEPT.	COMMENTS
A. GENERAL						
TECH. EXPERT	INDUSTRY	X				
	O.G.D.'s	X				
	RSCC	X				
	FEAR OFFICE	(X)				
GUIDELINE PREPARATION	PANEL (FEARO)	X	(X)	X		Process goes FEARO → Reg. Bd. Chmn. → RSCC
PANEL MEMBER	PANEL (FEARO - DM)	X				
INFO & ADVICE	INDUSTRY	X	(X)	X		
	O.G.D.'s	X		X		
	RSCC	X	(X)			
	FEAR OFFICE	(X)			(X)	
E.I.S. COMMENT	PANEL (FEARO)	X →	(X) →	X →	X	→ This is a chain (consequent to above)
- INTERVENOR	DM/ADM			(X)	X	
BASELINE DATA	D.M. O.G.D.'s	X	X	X	X	
B. SPECIFIC						
SURVEILLANCE	PANEL REPORT	X		X		Responsibility of department
MONITORING	PANEL REPORT	X		X		Responsibility of department

NOTE: (X) indicates possible but infrequent

SESSION 12 - FEARO PRESENTATION

P.G. Wolf

Discussion Summary

Lack of hydrologic data for northern Canada and ongoing panel hearings for major development have combined to create a situation where the assembly of baseline data research is concurrent with development hearings.

Western & Northern Region has now designated lead agencies to integrate agency planning for baseline programs. Panel participants who are federal staff act as individuals whose working time is lost to the seconding agency. The dearth of specialists in several aspects of the physical and biological sciences has resulted in the overuse of certain scientists. In some cases, the no-go option which should be available to panels has been removed by political decisions as in the Alcan hearings. No written guidelines for panel conduct exist presently. There is a fear that written guidelines will inhibit public participation and make the hearings a quasi-judicial process and permit the establishment of precedents which could then become the subject of legal wrangling. The inherent problem of this informal approach, most pronounced in Vancouver, is procedural argument and an unevenness of performance from one hearing to the next. Panels are enjoined to use all information supplied them during hearings, and private concerns to maintain confidentiality should not be heeded.

SESSION 13 - CURRENT PROGRAMS and NEW REQUIREMENTS for ENVIRONMENTAL IMPACT ASSESSMENT

J.E. Slater

Abstract

Two recent submissions to senior IWD management from respected scientists in the fields of hydrology and geomorphology suggest that traditional programs of WSC fail to supply sufficient data for scientifically sound impact assessment. Additional programs for the North should address water quality and sedimentation. Small basin research which addresses the hydrologic aspects of regional morphologic differences suggests that considerable modifications are indicated in present WSC networks. Aspects of this new work are now beyond the capabilities of operational staff and, if they are to be undertaken, will require input from DFE research agencies. In addition, the development of a baseline network northward into the islands is perceived as essential if we are to answer questions asked us today, in a scientific manner.

Taken together, network enhancement and baseline expansion represent a substantial new cost to our agency. If we proceed in this manner, it could well mean that current cash expenditures may have to be redirected to these programs from existing ones in the present constraint situation. In terms of water quality data, the most urgent need is to develop some national set of standards for sample collection, preservation and analysis so that the results emanating from various agencies can be compared and integrated. This does not seem to be possible with data now produced.

Discussion Summary

We must define our networks around the concept of uniform hydrologic and geomorphic zones so that generated data can be extrapolated with confidence. For water quality parameters such as major ion chemistry, this concept applies but it does not for determination of toxicity and nutrient levels. For water chemistry, long-term programs are not really necessary—the same could be said for several aspects of sediment programs.

Coöperation between operational and research groups in DFE will require much improved communication between these two groups. The collection of new data parameters at northern WSC sites will increase costs and no new funds appear to be available. Perhaps in the North, the thinking of WSC should be directed away from the collection of daily flows and to data sets such as frequency curves and the recording of extreme events. In this respect, modelling of streamflow might be most useful. New technology needs to be developed to measure peak flows when ice is present. Glaciology Division research on the Mackenzie has presented a photogrammetric technique to define surface velocity in running ice conditions. The combination of this information with techniques employed in moving boat measurements might be one way to derive peak flow data during ice runoff.

SESSION 14

STAFF TRAINING NEEDS - AGENCY RESEARCH INTEGRATION

Dr. H. Eisenhauer

Abstract

The purpose of the workshop has been to describe the approach taken by IWD in collecting information in the North which will permit the Directorate to comment authoritatively on the Environmental Impact Statement for the Arctic Islands Pipeline Project. This experience has revealed knowledge gaps and training needs. Research to provide the necessary new knowledge, and training programs to fill our requirements would permit IWD to collect and interpret the data more effectively for similar assignments in the future. The purpose of this session is to identify and discuss the training and research requirements for environmental impact assessment in the North. To initiate discussion, I have listed a few of these:

Training Needs

1. Placing field personnel at remote northern locations is expensive so it is desirable that they collect as much information as possible. Technicians may be asked to collect data with which they are not familiar. Thus, there is a need to train field technicians to assess, for example, the geomorphic characteristics of northern river basins.
2. For similar reasons, training is required to permit WSC field technicians to collect and preserve water quality samples to ensure that they are representative, and to assure sample integrity.

Research Needs

Specific problem-oriented applied research needs have been identified in the background papers. Some other more general and broader based needs have been implicitly alluded to during the discussion. These include the following:

1. The development of a methodology which will define the minimum amount of information essential to permit a reliable prediction of the probable environmental impact of a proposed project.
2. The development of a methodology to measure the reliability of an environmental impact assessment derived from a limited data base.
3. Identification of the type of information essential to carry out an environmental impact assessment in the North.

4. Identification of typical basin types on which data collection programs could be concentrated.

5. Development of modelling techniques specific to arctic basins which consider the unique effects of permafrost and the active layer.

I invite comments from the floor on these suggestions and on others which may occur to you.

Discussion Summary

The Water Research Advisory Committee meets twice a year and prepares a priority list of research projects. Regional directors input into those decisions. This process represents one avenue of communication between research and operations arms of our department. NWRI in Western & Northern Region is under tight constraint both in money and man-years. To provide research assistance requires redirection of existing programs. Presently, DFE is in an untenable situation in regard to the impact assessment process. The exercise of a no-go option is contingent upon DFE input. Scientists within government therefore feel coerced to make decisions and judgments in respect to an EIS even when there is insufficient data to do this scientifically. This is a form of prostitution of scientific principles. EIS assessment criteria, if established, will tend to worsen the situation. Suggested remedial action might be to convince FEARO of the need for more data, to refuse comment because of insufficient data, to define uncertainty levels for questionable data and conclusions, or to bypass the panel process with a direct recommendation to the minister.

However the scientific community proceeds, the public needs to be made aware of inadequate data bases for publicized judgments. Some improvement to the data base might be effected by collection of qualitative information for other agencies. Although such data would not likely be of high calibre, its judicious use might be of considerable benefit. Inter-agency training requirements, coördinated planning and close monitoring are necessary. Economies of scale could be realized from the integration of remote camps, fuel caches, etc. Common base camps would also facilitate inter-agency data collection.

SESSION 15 - WRAP-UP

Dr. D. Kerfoot

Some confusion existed in the minds of participants about the terms of reference for the workshop. A number of the presentations transferred data or information but not technology relevant to assessment of environmental impact.

It is easy to lose track of the purpose for an assessment process. Basically, that purpose is to come to grips with a reliable estimate of potential impacts of development on the natural environment. The role of scientists within government who are involved in this process is not to make decisions, but rather to make recommendations based on their interpretation of the environmental effects of a project. Such recommendations are then placed in a multi-disciplinary context and eventually reflected in the final decision. Loss of perspective ensues when we misunderstand the significance of our specialized concerns. Carson Templeton's values suggest that water-related concerns are only 2½% of the total. That perspective suggests that we should re-examine resource allocations for environmental assessment.

Another problem with the assessment process is its limited credibility —partly the fault seems to lie with FEARO itself. The traditional departmental stance, which has been to seek for deployment of resources at levels impossible to obtain, has harmed our credibility as well. The level of environmental research in the Mackenzie Valley, for example, where millions of dollars were spent by industry, by government scientific agencies and by the Berger Commission of Enquiry, now seems to have been largely misdirected, since the two factors which led to the "no-go" decision were known beforehand—the factors of terrain sensitivity in the North and the problems with the Porcupine caribou herd.

One input into the process is the development of guidelines which identify types of concerns to which the proponent must respond. This must be done carefully; series of generalized guidelines tend to produce motherhood statements of a kind which could be generated without any research, not conducive to a good departmental image.

A second input is at the EIS review stage during panel operations. A number of problems at this point in the process revolve around the level of information necessary, generally less than a scientist would ideally like. The goal should be to identify potential concerns which influence the "go" or "no-go" decision, not to judge design and engineering details. When guidelines call for such precise data, as they did for the gas-gathering system in the Mackenzie Delta while the whole project was still only in the conceptual stage, the process breaks down because no response was possible at that level of expertise.

Continued.....

Further input is possible at the design-review stage, through a newly created regulatory body or through existing groups like water boards or land-use boards. This is the type of review employed for the Dempster, Mackenzie and Liard highways, not as public a process as a FEARO project. Opportunities existed during these reviews to modify such things as culvert sizes, highway design and minor route changes. These results were just as significant as the highly visible FEARO process would have been, given that the "go" or "no-go" decision had already been made at the political level.

Participation by DFE in the review processes has created problems of time, workload and resource allocation. The development of in-house expertise to give DFE an independent stance within the review process is a luxury we can ill afford. The attitude creates duplication of effort between proponent-private programs and government efforts. Such programs can easily be perceived as implicit challenges to the integrity and competence of the proponent and its consultants.

To ease our task within this entire process, we need to make a thorough evaluation of what our real information needs are. Shopping lists and catalogues would seem to be unacceptable, since very little of such data is ever used in assessment. The data is valuable in terms of agency mandates, but for the most part doesn't address the problems posed by EIS review processes. If government agencies had been held sufficiently accountable for information requirements, if they had been posed questions such as, "What do you really want to know? Why do you want to know it?" and, "How do you propose to use such information?", government would have found some respite from the problems associated with time, workloads and resources. The extreme position would be for the department to assume an evaluatory position, not collect any data but simply assess proposals on their technical and scientific merit alone. In the political climate of today, this is a real possibility.

A second aspect of these suggestions has to do with the level of information a scientist would like to have before making a decision, and they would rather have more than less. Since most of the assessment decisions ultimately fall to scientists, the most urgent requirement here is to convince them to make do with substantially less data than they would like to have available. The record for this common-sense approach has not been too bad. In the assessment process, the application of common sense has proven to be just as useful as the basic principles of science. Politicians make decisions based on the much more tenuous criteria of political acceptability, so the scientific community would not be unique in adopting a less rigorous standard than is customary.

Thirdly, the workload occasioned by environmental assessment could be lessened if IWD improved coördination of activity and information exchange between research and operational agencies. It is suggested

that the coördinating function be a headquarters responsibility in the interests of efficiency, expediency and uniformity.

A further point which requires highlighting is the need to develop an expertise in salesmanship to address the question of initiation of long-term projects in the North. In terms of the IWD mandate, the requirement for northward expansion of the hydrologic network is clear. If senior management could be sold on the idea of multi-purpose uses for such new stations, of which environmental impact assessment is one, the agency could probably realize more of their goals than presently. In this respect, the value of basin studies should be stressed. They will help IWD fulfill their network mandate, if located near to proposed development, will address impact problems and will finally lead to solutions such as models which can be extrapolated or the development of predictive capability. This approach will enhance the agency's chances of success in northern expansion. A further selling point to be considered for future work will be the need to evaluate predictions of impact that have been made or are now in the process of being made. This has not yet happened in Canada but it is a clearly perceived need. We must follow through to determine to what extent predictions were justified, to what extent accurate and to what extent these original statements can be broken down further in order to identify key indices. This will allow us to evolve an expertise to apply to new projects. The long-term baseline program, if implemented judiciously, can be seen to be highly supportive to environmental impact assessment, a high profile, high priority item with DFE senior management. Our senior ADM is committed to this approach and to this kind of work.

Companion events, now active, will clarify the situation. The relationship between DFE and FEARO is under investigation so that individuals' roles are more clearly defined—when do they speak as an independent scientist and when for the department. The departmental split into DOE and DFO and where environmental assessment responsibilities will fall is still unresolved.

Finally, a proposal for a baseline studies program, *per se*, is being evaluated. This program is founded on regional inputs and foreseeable development prognoses and identifies common themes, common areas and focal points to meet potential requirements for evaluation of development. Although such a program is highly desirable, its early implementation may well mean the reallocation of departmental resources from existing programs.

This summary describes some of the points raised during the workshop and some as I saw them. It seems that much will be resolved by companion events inside the department and by a most stringent review of internal coördination and operation.

Session 15

Discussion Summary

There seem to be three levels of data requirements, the least of which is for environmental impact assessment.

When AIPP was set up to gather information, we realized that sometime in the future, terms and conditions would have to be set. This requires a higher level of information. In addition, IWD has the mandate for long-term data on water resources. Very limited data was available from this area to satisfy the three concerns.

As data gatherers, we considered it our responsibility to gather as much information as possible. It is true that only a certain portion of the information was directly applicable to the EIS. However, the remainder of the information is also of great benefit when satisfying the remaining concerns listed above. When the situation is viewed with these considerations in mind, it is apparent that some of the resources were used for data collection which was not directly related to the EIS, but would have application at some later stage in the process. To this degree, WSC must be opportunistic.

Perhaps all that is required is to apply technical and scientific expertise to evaluate the proposal and determine if the proposal makes sense according to the general information that you have already collected. It must also be determined if the actual solution being proposed and the data being presented to support it alleviates the types of concerns that you identified when you did your initial impact assessment.

SESSION 16 - WORKSHOP EVALUATION

Dr. H. Eisenhauer

All participants were provided with a workshop critique form and invited to return it to the organizers with comments. The return of 22 critiques, representing more than 50% of the attendees, was considered to be quite high. The following is an analysis of these.

1. Facilities

The room used for the workshop was classroom-style with seven rows of seven anchored swivel chairs and tables facing the slightly raised platform at the front. This "lecture" area contained a lectern, tables, overhead projector and screen. All the tables and the lectern were equipped with microphones. Slides, which were projected from a rear projection room, could be changed by the speaker at the lectern. The proceedings were taped on a casette recorder.

All but one of the respondents felt that the room was the right size but one-third did not think the seating arrangement was satisfactory. Several commented that the rigid seating arrangement was too formal and inhibited spontaneous discussion. A number suggested that the participants should face one another for the discussions suggesting circular, rectangular or U-shaped seating arrangements. One respondent noted that it was an advantage to have tables. Everyone agreed that the audio-visual equipment was satisfactory.

2. Format

The workshop was composed of five half-day sessions dealing with different aspects of environmental impact assessment in the North. The two or three related topics in each session were introduced by speakers from the podium. Following presentation, discussion of each topic was invited. The time allotted for each topic was 45-90 minutes, with one-third scheduled for the presentation and two-thirds for the discussion. Session chairmen were responsible for keeping their sessions on schedule and for leading the discussions. Coffee breaks of about 15 minutes were scheduled for mid-way in each session. On the first evening, an informal reception (wine-and-cheese party) was held.

Twenty-one respondents felt the number of topics was sufficient to deal with the subject adequately, while one thought there should have been more. Fifteen percent of the respondents thought the presentations were too formal, while the others agreed they were satisfactory. Although most speakers exceeded their allotted time by 50-100%, all but one of the respondents thought the time taken for presentation was satisfactory.

Everyone agreed that the discussions should be held as they were after each presentation, but one in six felt there was not sufficient time for a proper discussion. One person recommended an additional general discussion following each half-day session. One-third of the respondents felt that the discussions were not sufficiently interactive and spontaneous. The reasons suggested for this include:

- the wide variety of topics were not all of interest to all the participants;
- the group was too large;
- the classroom arrangement inhibited discussion;
- session chairmen were not sufficiently familiar with attendees to invite comments from specific individuals.

One respondent suggested this could be improved by dividing the workshop into smaller discussion groups, each dealing with a narrower range of topics of direct interest to the group. Another recommended a structuring of the program to highlight and concentrate topics for discussion. A third felt that specific individuals could have been asked for comments to draw them into the discussion.

All respondents felt that for the most part, the session chairmen did a satisfactory job in stimulating discussion. It could have been improved by having the chairman highlight the salient points of each presentation, add his own comment, invite comments from specific individuals, and direct the discussion to the technology transfer aspects of the workshop subject. The use of "comment" cards was recommended by one respondent as a means whereby the chairman could organize the discussion, and it was suggested that it would be useful for the session chairman to meet with the speakers prior to the session to help in the coördination of presentation and discussion. One person underlined the requirement that session chairmen should be familiar with and active in the subject matter being presented. He felt that this was successfully done in this instance.

Of those attending the social hour, all but two felt that it was of value in "breaking the ice" and stimulating more useful informal discussion. Everyone thought there were enough coffee breaks and most thought sufficient time was allotted for this purpsoe. Two people felt that the breaks were too short, one suggesting that a longer break would permit participants to become acquainted with one another and allow them more time to discuss topics of mutual interest. (Incidentally, this respondent did not attend the wine-and-cheese party.)

3. Material

The technical workshop series has been initiated to improve the transfer of technology between those who develop it (usually, but not exclusively, researchers in IWD and elsewhere) and those who use it in IWD, that is, the field and laboratory staff of the Directorate. The intended primary purpose is to improve IWD's capability to fulfill its operational responsibilities, A secondary objective is to identify the knowledge gaps requiring research. The primary purpose in relation to the subject was not apparent to 40% of the respondents, evidently because most of the sessions appeared to deal more with information and experience exchange than with technology transfer. Furthermore, one-third of the respondents felt the workshop did not achieve its purpose as they perceived it, although several said it did so to some degree, insofar as there was considered to be a valuable exchange of technical know-how between those who have worked in the North, and those who might reasonably expect to do so in the future.

One-half of those who returned the critique forms felt that the workshop did not cover its subject adequately. Many of them took this view because they felt most of the presentations dealt mostly with how to gather information rather than how to use such information to assess environmental impact. Indeed, only 70% said that the topics chosen were pertinent to the subject. One had the view that the water chemistry topic was irrelevant. On the other hand, another thought the workshop should have had an increased emphasis on the water quality aspects. The topics were selected by the IWD Directors from a program proposed by the workshop organizers. There were no positive suggestions as to how this selection process could be improved.

The organizers of the workshop asked all speakers to provide them with written papers and/or background information so that they could be forwarded to all participants well in advance of the workshop. Because of the inevitable delays in receiving the papers, coupled with the advent of a mail strike, incomplete sets were received by participants only a few days before the workshop (if at all). It is not surprising therefore that one-third of the respondents felt that there was not enough preliminary information and that one-quarter thought the topics were not covered adequately. However, 80% of those replying found the preliminary information useful and, in one case, "absolutely necessary". Another attendee recommended that the mailing should have included information on the purpose and objectives of the workshop as well as other general information on arrangements.

Nine out of 10 people thought most of the oral presentations were adequate in providing information, and everyone agreed that there were a sufficient number of visual aids.

Proceedings of the workshop, which include an edited transcript of the discussions, will be issued. It was agreed by nearly all the respondents that this was adequate without any additional follow-up.

4. Participants

It was the subjective opinion of the organizers that attendance at the workshop should not exceed 40-45, including the speakers. IWD Directors were asked to nominate attendees, and the final attendance was determined at an IWD Directors' Committee meeting. It was thought by 80% of the respondents that there were enough participants to promote a workshop atmosphere and generate interactive discussion. Fifteen percent thought there were too many. One person felt that additional technical people and representatives from the Northwest Territories should have been invited. One-half of those responding thought the selected participants were not the best possible for the purpose of the workshop. Several of these commented that it would have been better to have had a broader range of interests represented with more researchers, managers, water quality people, and representatives from DINA. Another thought there should have been fewer from the policy and planning area and more from those segments actively involved in the work which the workshop was addressing. On the other hand, one respondent commented that the selection of participants was "good and inclusive"; another said, "I was certainly very pleased to see the "mix" of participants, i.e., some program planners, data collectors, data users both from industry and EARP, and researchers."

5. General

All respondents thought this method of technology transfer was useful, notwithstanding some of the reservations noted earlier. Several commented that the workshop would have been more correctly labelled "information exchange" rather than "technology transfer". One person suggested that the workshop could have been improved if the attendees broke into several small groups for in-depth technical discussions. A second said that the workshop should attempt to achieve an appropriate balance between a description of the available technology and an identification of technological needs. A third pointed out that detailed knowledge transfer can best be achieved on a one-to-one basis. In answer to the question, "Is this method of technology transfer useful", another respondent replied, "A very emphatic "YES". We have tried conferences, symposia, training courses—both in-house and non-governmental—to tell people what is being done. They are expensive, too many non-experts attend, they are time-consuming and they just haven't done the job. This type of workshop has great possibilities."

Ninety percent of the respondents found the workshop personally useful. Some suggested it would have been more useful if a broader range of topics, e.g., water quality, had been addressed. One suggested that there was insufficient discussion on the assessment of impacts and of remedial measures, and another would have liked to have had more discussion on operational problems and possible solutions.

6. Recommendations

Attendees were asked to provide additional suggestions which would improve future workshops of this nature (including subject matter, format, discussion, formality, number and representation of participants, etc). The following summarizes the recommendations from 13 of the respondents, and from the body of this evaluation report.

6.1 Facilities

For discussions, seating arrangements should be such that the participants are facing one another (circle, U-shape or rectangle).

6.2 Format

- Increase time allotted for discussion;
- Break into smaller groups for discussion of related topics at the technical level, then report back to the plenary session;
- Provide an opportunity for informal discussion between sessions;
- Session chairmen should invite comments from specific individuals to promote interactive discussion;
- Following the general presentations, consider the use of informal discussions based on poster sessions which emphasize technology;
- At end of each day, critique the presentations,relating them to the workshop subject

6.3 Material

- Define the purpose and objective of the workshop more explicitly and ensure that its title clearly reflects the subject;
- Clearly separate topics on policy from those on technology transfer;
- Topics should emphasize "technology transfer" rather than just "information transfer";
- Preliminary information should include all papers to be presented and should be received by participants well in advance of the workshop;
- Preliminary mailing should include information on organization, arrangements and orientation for the workshop;
- A review panel should determine the relevance of the presentations to the subject of the workshop before any are accepted;
- There should be a final session dedicated to the users of the technology.

6.4 Participants

- Increase the breadth of interest represented by the participants including substantial numbers of researchers and managers;

- Consultants and other agency representatives in the local area should be invited to attend the final "user" session proposed in 6.3 above.

6.5 Future Workshop Subjects

- Collection and preservation of water quality samples;

- Water quality data collection and interpretation techniques;

- Personnel training needs related to data collection requirements in the North;

- From a review of this workshop, identify principal concerns and problems and organize future workshops to focus specifically on these issues.

PREMIÈRE PARTIE

RÉSUMÉS ET DISCUSSIONS

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SESSION 1

ÉVALUATION DES RÉPERCUSSIONS ENVIRONNEMENTALES DANS LE NORD

J.E. Slater

Résumé

Toute bonne évaluation des répercussions environnementales ne peut se faire qu'à partir d'une base de données intégrée. On doit être en mesure de décrire les conditions antérieures: les phénomènes hydrologiques, atmosphériques, géologiques et biologiques ainsi que la valeur esthétique et le niveau d'utilisation des terres et des ressources naturelles avant l'aménagement prévu. On devrait posséder suffisamment de données pour prévoir les conditions qui seront modifiées par suite de la mise en valeur et pour suggérer les solutions de rechange qui permettront d'atténuer les effets probables. Les restrictions budgétaires, de main-d'oeuvre et de temps et les autres contraintes politiques et technologiques agissent de concert pour entraver l'acquisition des données dans le Nord. Ainsi, les résultats, surtout ceux qui se rapportent à l'hydrologie, sont beaucoup trop subjectifs pour se fonder sur des principes scientifiques établis. Les hydrologues doivent donc être extrêmement prudents lorsqu'ils choisissent les emplacements représentatifs, déterminent les paramètres à analyser et fixent les périodes d'échantillonnage. Dans les jours à venir, on recueillera des informations provenant de divers groupes intéressés au Nord canadien.

Discussion

Aucune.

SESSION 2 - PRÉSENTATION DES DIAPOSITIVES DU PPIA

J.G. Way

Résumé

La présente session audio-visuelle comprend une série de 25 à 30 diapositives accompagnées de commentaires descriptifs. Elles proviennent d'un ensemble de plus de cent photographies prises au cours des études de régimes hydrologiques du PPIA, effectuées entre 1975 et 1977 inclusivement. Elles illustrent, entre autres, les formations et les phénomènes fluviaux de même que les formations terrestres le long du parcours projetté pour le pipeline <<Polar Gas>>. Les diapositives qui traitent de l'instabilité riveraine et des processus géomorphiques susceptibles d'apporter des modifications à la conception, la construction et l'entretien du pipeline, constituent la plus grande partie de la présentation.

La projection des diapositives est organisée dans un ordre géographique (soit du sud au nord) plutôt que temporel, afin de démontrer la transition depuis la forêt boréale du sud du District de Keewatin aux prairies de roseaux en terre humide et aux hautes-terres arides de l'intérieur des Îles Reine-Élisabeth. La présentation servira d'entrée en matière aux sessions subséquentes.

Les diapositives susmentionnées vont servir de base à un ensemble audio-visuel de 100 diapositives, destiné à mettre en lumière le rôle joué par la DGEI dans le <<Projet de pipeline des îles de l'Arctique>>, que la Direction de la planification et de la gestion des eaux à Régina est en voie de préparer.

Discussion

Les îles centrales de l'Arctique ne comprennent que deux stations hydrométriques chargées de recueillir périodiquement des données sur les niveaux d'eau et les débits. Depuis 1972, les stations sont de service sur une base saisonnière. Elles se trouvent à proximité du centre d'approvisionnement de Resolute afin d'en réduire les coûts d'exploitation. Quoiqu'aucun projet spécifique n'ait porté sur l'infiltration des eaux souterraines dans les cours d'eau, il semble que le pergélisol persiste pendant toute l'été à environ un mètre du lit de cours d'eau complètement recouverts de glace en hiver.

Dans l'Arctique du sud, c'est-à-dire du centre au sud du District de Keewatin, les terres peuvent être recouvertes à 100 %, tandis que les terres des îles centrales sont généralement arides en

raison des teneurs élevées en carbonates. La majeure partie de la végétation croît dans des vallées abritées lesquelles pourraient être définies comme étant des <<oasis>> de l'Arctique. La vallée du passage Polar Bear sur l'Île Bathurst en est un exemple.

Même s'il n'existe pas beaucoup de données à l'appui, les taux de sédimentation dans l'Arctique semblent être faibles sur une base annuelle, alors que les taux de pointe au cours des inondations printanières ou lors des pluies de fin d'été semblent être relativement élevés.

Les emplacements retenus pour l'étude se trouvaient à proximité de la route principale et des tracés de rechange du pipeline; ils étaient tenus pour représentatifs des régions en bordure du couloir du pipeline. Le défenseur s'est servi des conclusions préliminaires pour modifier le tracé du pipeline et écarter les options de rechange.

La description des cours d'eau à partir des processus géomorphiques connexes paraît être efficace. Elle ne fait pas partie intégrante des programmes réguliers de la Division des relevés hydrologiques du Canada à Winnipeg, mais elle peut être incorporée dans les activités courantes en vue d'obtenir des données au nord du 60^{e} parallèle.

SESSION 3

PROJET DE PIPELINE DES ÎLES DE L'ARCTIQUE: Buts, objectifs et programme élaboré pour le projet d'eau douce n° 1

J.E. Slater

Résumé

Selon le mandat du groupe d'étude, il avait pour tâche d'examiner les effets qu'aurait un gazoduc enfoui sur les cours d'eau qu'il traverse. Les travaux se sont limités aux régions au nord du 60e parallèle en raison de la juridiction provinciale. Il a fallu trouver des réponses à deux questions fondamentales:

1. Dans quelle mesure la construction et l'exploitation d'un pipeline toucheront-ils au milieu hydrologique, à savoir les lacs et rivières le long de la route?

2. Quels aspects morphologiques et hydrologiques des cours d'eau affecteront la conception, la construction et l'exploitation d'un tel pipeline?

Les principales contraintes exercées sur l'étude étaient des questions d'échéance et de fonds. La période prévue, 2 à 3 ans, ne permettait pas d'obtenir des données sur les paramètres hydrologiques et géomorphiques de la façon ordinaire qui se fonde normalement sur une analyse des statistiques emmagasinées sur un intervalle de plus de 10 ans.

L'absence d'un réseau hydrologique au nord du District de Keewatin (une station sur l'île Cornwallis) a entravé la diffusion des données. Cependant, une description qualitative des caractéristiques fluviales a pu être dressée à l'aide de cartes, de photographies aériennes et de deux campagnes d'échantillonnage pour l'analyse des paramètres pertinents à 27 emplacements de cours d'eau. Les résultats de l'échantillonnage, ultérieurement rassemblés dans un catalogue, traitaient de l'écoulement, de la concentration des sédiments, des matériaux de fond et de berge, des conditions du sol et de la glace, des caractéristiques des plaines inondables, de la pente des rivières et des approches aux murs des vallées.

En plus d'être utiles au groupe d'étude, les données ont servi aux chercheurs de plusieurs autres disciplines connexes. Même si les études n'ont engendré que peu de données, l'examen des processus fluvio-morphologiques des régions pergélisolées à terres arides a permis de définir provisoirement certaines régions fragiles aux activités de pipeline sur le plan environnemental.

Discussion

Les organismes gouvernementaux n'ont effectué que très peu de travaux additionnels sur la route au sud du 60^{e} parallèle, quoique les experts-conseils aient entrepris quelques autres recherches de base.

Les experts-conseils ont échangé leurs données sur la région au nord du 60^{e} parallèle afin d'éviter que des recherches identiques et des données de base analogues n'aient lieu. Leurs travaux sur le terrain se sont limités à l'examen de paramètres n'ayant fait l'objet d'aucune étude préalable, c'est-à-dire à des programmes de forage pour déterminer les températures du sol et prélever des matériaux dans les vallées des rivières. L'étude des cartes avant les travaux sur le terrain a donc été considérée comme essentielle. Les études préliminaires ont engendré plusieurs changements dans le tracé des routes et maintes modifications aux plans originaux, y compris le réacheminement autour du passage Polar Bear sur l'île Bathurst, le réacheminement en direction de l'est dans les basses-terres de Rasmussen au sud de la baie Spence et la proposition concernant le lac Stanwell-Fletcher sur l'île Somerset.

Sur le plan hydrologique, les trois principaux changements de conception, découlant des études, ont porté sur les pipelines surélevés des rivières Thelon et Tha-Anne et sur la sélection d'un nouvel emplacement sur la rivière Kazan.

La proposition formulée au cours de la troisième année n'a fait l'objet d'aucun versement. Elle prévoyait une étude, entre les organismes, sur la recherche appliquée qui permettrait de manipuler les conditions naturelles des cours d'eau à partir d'un bassin versant bien instrumenté.

SESSION 4 - FACTEURS ENVIRONNEMENTAUX AXÉS SUR L'EAU

R.J. Lane

Résumé

Il est évident qu'une approche gouvernementale à la fois coûteuse et accélérée, visant l'aménagement du Nord canadien, n'est plus à la mode aujourd'hui. C'est pourquoi la DGEI et le MPE sont à élaborer un programme d'évaluation de l'environnement dans le Nord. Théoriquement, la DGEI doit, en vertu de son mandat, fournir les conseils permettant une évaluation initiale de l'environnement, nommer le personnel nécessaire pour assurer une participation active aux commissions d'évaluation, participer à la préparation des directives pour les énoncés des répercussions environnementales et examiner les rapports qui en découlent.

À vrai dire, la DGEI n'est pas obligée d'y effectuer des études, sauf si ces dernières sont payées par un Initiateur ou si la Direction ne peut pas fournir les conseils qu'elle s'est engagée à donner. Dans le cas d'études quantitatives, le gouvernement fédéral s'occupe du débit des eaux interprovinciales et des ententes sur les eaux internationales, lesquelles traitent également des oiseaux aquatiques et du climat. Toute variation du débit de ces eaux suite à leur mise en valeur peut altérer l'inventaire que tient le gouvernement fédéral. Les inquiétudes des divers organismes oeuvrant dans le Nord portent à présent sur les dommages dus aux inondations, les changements dans les eaux navigables et les pertes d'habitats de poissons et d'oiseaux aquatiques. Les principales préoccupations sur la qualité des eaux s'appliquent aux eaux interprovinciales et internationales. Il reste à définir la pollution causée par les substances toxiques en fonction des problèmes engendrés, des paramètres échantillonnés et des modèles de prévision établis. D'autres inquiétudes sur la qualité des eaux sont liées à la radioactivité, l'eutrophisation, les déversements d'huile et l'évacuation des eaux de condensation. Toute expansion du réseau actuel pour l'évaluation des répercussions doit être minimale et les coûts partagés de préférence avec les autorités provinciales ou territoriales.

Discussion

Une discussion animée a traité de l'accroissement du réseau dans le Nord. Elle a mis en relief la grave pénurie de stations dans le District de Franklin. Une partie de l'expansion requise fera sans doute l'objet d'une répartition des coûts avec le MAIN.

Quant aux nouvelles stations n'étant pas subventionnées de la sorte, un rapport complet et approfondi devra faire état des inquiétudes spécifiques de la DGEI. Un soucis majeur de la DGEI correspond au système de transport de carburant dans le Nord et ses effets sur des centaines de petits croisements fluviaux. Une solution repose sur l'identification des régions hydrologiques homogènes et sur la sélection de bassins représentatifs, ce qui permettrait de définir des paramètres régionaux. La grande flexibilité des politiques gouvernementales rend extrêmement difficile l'expansion à long terme du réseau de base de sorte que les directeurs de la DGEI doivent à l'heure actuelle se servir de beaucoup d'ingénuité pour obtenir un retour maximum de données à partir de l'argent et de la main-d'oeuvre disponibles.

SESSION 5 - CARACTÉRISTIQUES MORPHOLOGIQUES DES BASSINS DE DRAINAGE IMPORTANTES POUR L'HYDROLOGIE DANS L'ARCTIQUE

W. Rannie

Résumé

Dans les cas où des données précises sur l'écoulement et les sédiments sont rares, l'examen des caractéristiques des bassins peut faciliter les études comparatives à l'échelle de la région et entre les régions. Les caractéristiques de bassins spécialement importantes pour l'hydrologie dans l'Arctique sont l'aspect et le relief du bassin, la répartition du relief, la densité de drainage, la surface de drainage, la superficie des lacs et l'historique des glaciers. La morphologie permet en outre de dresser des équations de prévision. L'aspect du bassin sert à expliquer les variations dans la latitude thermique d'un bassin, la profondeur de la couche active, la végétation, la précipitation et la distribution de la neige. Le relief, dans un sens large, définit les pentes possibles d'énergie et sert donc d'entrée dans les modèles de rendement des sédiments et des débits. La répartition du relief se rapporte aux variables climatiques qui sont sensibles à l'élévation, par exemple la précipitation, la température et la condensation. L'analyse de la densité de drainage permet de mieux comprendre le régime de transport des sédiments sur les pentes des collines et le cheminement des cours d'eau, ce qui explique l'équilibre dynamique des deux systèmes.

Le rôle des lacs de dégel et des dépressions rapprochées rend assez difficile le calcul de la surface de drainage qui revêt un caractère important sur le plan hydrologique. Il s'agit d'un paramètre d'évaluation des plus utiles puisqu'il se rapporte à l'inondation annuelle moyenne, à l'écoulement annuel moyen, à l'inondation maximale, au débit de pointe quotidien et à la charge unitaire de sédiments. La présence de nombreux lacs ou de lacs à grande étendue dans un bassin de drainage entrave l'évaluation précise des paramètres hydromorphologiques régionaux. Le concept de paraglaciation correspond aux taux de sédiments plus élevés que d'ordinaire dans les bassins récemment déglacés et il doit être pris en considération lors de l'analyse régionale dans l'Arctique. Une équation de la charge de sédiments, établie à partir de paramètres morphologiques, est présentée puisqu'elle semble être efficace pour l'évaluation préliminaire des taux de transport de sédiments à l'échelle régionale.

Somme toute, les bassins de l'Arctique présentent un nombre de caractéristiques communes à celles des bassins urbains et semi-arides. En passant en revue les modèles disponibles, il serait possible d'appliquer certaines de leurs données aux programmes dans le Nord.

Discussion

Il existe un bon nombre de jours à la station météorologique de Resolute où la précipitation quotidienne correspond à des quantités identifiées par le terme <<trace>>, soit une précipitation inférieure à 0,01 pouce. L'analyse statistique du taux de précipitation estivale montre qu'une grande partie des mesures effectuées à la station sont identifiées par ce terme. Il va sans dire que les erreurs d'exactitude sont alors plus prononcées. Dans les régions où les chutes de pluie sont très faibles, même les plus petites erreurs d'échantillonnage deviennent considérables. Comme l'évaporation est habituellement déterminée en fonction du bilan hydrique, les données sur l'évaporation ne sont pas exactes en raison du manque de données de précipitation. Plusieurs bassins de drainage dans le Nord comprennent en outre des étendues qui n'ont pas de tracé de drainage déterminé. De plus, maints cours d'eau de l'Arctique sont fortement anastomosés en aval, ce qui accentue les difficultés quand il faut évaluer les densités de drainage. L'étude morphologique permet-elle de résoudre certains de ces problèmes? Pas exactement étant donné que la plupart des études morphométriques qui peuvent être intégrées avec succès aux études hydrologiques sont menées dans des bassins de drainage bien définis ou <<classiques>>. En somme, la densité de drainage dans l'Arctique n'est pas d'une grande utilité lorsque les cours d'eau sont très anastomosés.

Il est plus facile d'établir un modèle pour la zone continue de pergélisol. Il s'agit de prendre les taux de fonte de neige et d'en tracer le parcours à la surface du sol. Les régimes d'écoulement de l'Arctique comptent parmi les plus simples même si l'acquisition des données y est difficile. Il est sans doute plus aisé de les analyser qu'un bassin versant normal, agricole ou forestier.

SESSION 6 - ÉTUDES DE LA MORPHOLOGIE DES RIVIÈRES

R.W. Newbury

Résumé

Quant à l'auteur, la morphologie des rivières est essentiellement un concept de <<bonne forme>> - concept très difficile à décrire puisqu'il ne peut pas être défini de façon précise même s'il est basé sur des faits scientifiques.

La bonne forme dans les systèmes naturels explique comment un système s'adapte aux autres, comment il s'harmonise avec l'ensemble pour former un tout unifié. Les répercussions environnementales constituent des *déviations* à cette bonne forme naturelle. La bonne forme du système d'une rivière peut être décrite en examinant le cheminement au hasard du réseau de drainage qui est lié aux autres réseaux naturels tels ceux des arbres et des vaisseaux sanguins.

Les rapports entre l'ordre et la longueur des embranchements demeurent constants, peu importe l'étendue du bassin. Un deuxième concept de bonne forme étudie la distribution verticale du système d'une rivière en introduisant le concept d'énergie du ruissellement. Ce concept stipule que des segments égaux de lits de rivière en matériaux non consolidés produisent des quantités égales d'énergie. Dans une situation typique où les profils concaves se dirigent vers le haut, les tronçons supérieurs de cours d'eau ont une pression plus élevée, mais moins d'eau que les tronçons inférieurs. Les systèmes naturels des rivières permettent de rétablir l'équilibre lorsque l'homme apporte des modifications au régime.

Deux exemples de systèmes en <<mauvaise forme>> dans le nord du Manitoba sont la dérivation de la rivière Churchill dans la rivière Nelson et l'augmentation des niveaux d'eau du lac sud des Indiens. Ces perturbations n'ont aucune conséquence sur le plan géologique à long terme, mais produisent un impact sérieux sur l'environnement lorsqu'elles sont prises sur une période à court terme de 50 à 100 ans, soit le temps requis pour la planification normale de l'aménagement sur une plus grande échelle.

Discussion

Même si les deux exemples de mauvaise forme constituent un impact négatif, ceci ne se produit pas nécessairement dans chaque cas, à

titre d'exemple, la rivière Niagara. Une étude du processus et de la forme produit des solutions d'aménagement heureuses et dans certains cas, un impact positif; par exemple, les centrales hydro-électriques sur la rivière Churchill plutôt que sa dérivation dans la rivière Nelson. Les prévisions quant aux effets de cette dérivation étaient relativement exactes sur le plan physique, moins que bonnes sur le plan biologique et complètement fausses sur le plan sociologique. La rivière Churchill inférieure, petite rivière modifiée en grande vallée depuis sa dérivation, constitue une modification unique à un régime fluvial présentant de nouveaux problèmes d'environnement comme la congélation et la perte de frayères dans les lacs asséchés. Il s'agit là de problèmes n'ayant fait l'objet d'aucune recherche antérieure et les renseignements sur leurs effets à long terme sont restreints.

SESSION 7 - PROGRAMMES D'ACQUISITION DES DONNÉES MORPHOMÉTRIQUES ET HYDRAULIQUES

J.G. Way

Résumé

L'exposé porte sur les techniques d'acquisition des données utilisées dans le Projet de pipeline des îles de l'Arctique. Le choix des emplacements s'est fait à l'aide de cartes et de photographies aériennes comme pour les données recueillies sur l'ordre des cours d'eau, les coefficients hypsométriques, les intégrales, la superficie des bassins, la longueur des rivières et la longueur et largeur périmétriques des bassins aux emplacements retenus. Les travaux sur le terrain ont comporté l'échantillonnage des sédiments en suspension, des matériaux de fond, des débits des cours d'eau, de la qualité des eaux, et de la profondeur du dégel. Les renseignements tirés de l'étude qualitative du terrain avoisinant ont été reportés sur des formules préparées à cette fin et des travaux ont été accomplis sur les caractéristiques hydrauliques des chenaux. Des analyses ultérieures ont traité de l'étendue potentielle des inondations aux emplacements étudiés.

Afin d'intégrer ces techniques aux programmes courants, il faudrait s'assurer de la formation du personnel.

Discussion

L'étude du bureau de la région du Pacifique et du Yukon a pris moins de temps que les études du PPIA et a fourni une description assez détaillée des trois facteurs hydrologiques suivants: le débit des cours d'eau, la qualité des eaux et l'érosion due à la sédimentation. L'analyse du débit des cours d'eau s'est faite en ayant recours aux études de régression, à la géométrie des chenaux et au modèle à ondes cinématiques alors que les travaux sur le terrain et l'inventaire des autoroutes du MTP ont servi à dresser la liste des données sur les sédiments et l'érosion. Quelques équations du régime ont alors pu être établies. Dans les études qu'elle a menées, la firme <<Polar Gas>> a tenté d'utiliser les images fournies par satellite; malheureusement, le ciel étant recouvert de nuages, elle n'a pas pu obtenir les données souhaitées. De plus, tout indique que les photographies aériennes prises aux croisements de rivières auraient pu offrir un bon nombre de données à un coût relativement faible. Selon les chercheurs de <<Polar Gas>>, il est seulement possible de

tirer quelques conclusions qualitatives sur les problèmes de croisements spécifiques. L'échange de renseignements entre les divers organismes pour les régions pour lesquelles les données sont rares ou tout à fait inexistantes semble être la méthode la plus efficace et la moins coûteuse d'obtenir les données essentielles à l'évaluation des répercussions.

SESSION 8 - PERSPECTIVE DU BIOLOGISTE QUANT AU RÔLE JOUÉ PAR LA CHIMIE DES EAUX DANS L'ÉVALUATION ENVIRONNEMENTALE

E.K. Langtry

Résumé

La chimie des eaux est importante dans l'évaluation environnementale, quoique les études classiques aient souvent négligé la prévision des répercussions. L'analyse biologique en soi ne peut pas définir la qualité des eaux de façon précise; il faut donc la mettre en corrélation avec les propriétés chimiques des eaux.

Le facteur de variabilité dans les données chimiques peut être contrôlé à partir de techniques normalisées. Une manutention et une analyse appropriées des échantillons par des techniciens compétents permet d'éliminer la variabilité due aux erreurs humaines. La variabilité spatio-temporelle des eaux naturelles peut être évaluée, elle, avec précision en choisissant les périodes d'échantillonnage avec soin et en concevant de bons réseaux. Les études chimiques atteindront leur valeur maximale une fois qu'elles auront été intégrées aux recherches réalisées dans d'autres domaines connexes.

Une compréhension complète du processus écologique peut s'acquérir en effectuant des recherches approfondies sur les systèmes aquatiques à l'étude plutôt qu'en recourant à un inventaire pré-établi. Les prévisions faites à l'aide des modèles élaborés permettront d'ailleurs de mieux évaluer les répercussions environnementales.

Discussion

La qualité des eaux qui a longtemps été reconnue comme synonyme de la chimie des eaux est en fait une évaluation de l'environnement aquatique pris comme un tout; elle sert à mesurer les paramètres physiques, chimiques, biologiques et sédimentologiques. La recherche doit porter sur les données du système et sur les processus en cause et non uniquement sur l'inventaire. L'étude des écosystèmes complexes et la surveillance de leurs variations se compliquent davantage par suite des contraintes dans l'administration et la conception; par exemple, les fonds requis pour mener les études du PPIA sur la limnologie et les études qualitatives ont été difficiles à obtenir de l'administration. La communauté scientifique ne doit pas seulement se signaler par

d'excellents scientistes dans ce domaine, mais par de bons vendeurs. La méthode la plus efficace et la moins coûteuse de recueillir les données serait l'analyse d'un système représentatif, c'est-à-dire qu'il faut laisser l'acquisition des données de l'inventaire entre les mains du défenseur et confier les études sur le terrain au gouvernement. Les études d'emplacements représentatifs choisis avec soin sont d'une importance suprême. Les paramètres biologiques dans l'Arctique sont essentiels, mais en raison des visites peu fréquentes il est possible que les variations biologiques à court terme ne soient pas constatées. Un exemple de ce phénomène s'est produit lors des études de la route de l'Alaska; elles ont signalé que l'oxygène des eaux recouvertes de glace diminuait de sorte qu'une étude microbiologique a été entreprise pour déterminer la demande d'oxygène sous la glace. Ce phénomène aurait sans aucun doute été négligé lors des visites habituelles. L'approche intégrée des relevés effectués sur le terrain est fonctionnelle dans la région de l'Atlantique et jusqu'à un certain point pratique dans la région de l'Ouest et du Nord.

SESSION 9 - ÉTUDE DE BASSIN: ÎLE BATHURST, 1976

J.H. Wedel

Résumé

Une étude de bassin approfondie a été entreprise à l'ouest de l'île Bathurst durant la deuxième année du Projet de pipeline des îles de l'Arctique. Le bassin qui se trouve dans une région dont les terres sont moyennement incohérentes, n'avait pas fait l'objet d'études hydrologiques complexes auparavant. Les travaux effectués sur le terrain ont permis d'obtenir des données hydrologiques, météorologiques et sédimentologiques pour la période de ruissellement de 1976. Les analyses subséquentes ont fourni un rapport empirique sur le ruissellement calculé à l'aide des données de précipitation de la baie Resolute, quelques modèles mathématiques décrivant la fonte des neiges, le débit des sédiments et le débit des cours d'eau, de même que des valeurs pour le bilan hydrique du bassin. Les résultats ont indiqué que les taux de ruissellement et de sédimentation annuels étaient plus élevés que ceux qui ont paru dans l'*Atlas hydrologique*.

Discussion

La sensibilité du terrain identifiée en 1975 a servi de base pour la sélection du site. Un meilleur site en termes de taux de sédimentation plus élevé et de phénomènes de mouvement en masse aurait probablement pu se trouver dans les dépôts de limon et de schistes des affleurements des Eids qui se trouvent à 25 miiles plus à l'est ou sur un emplacement à l'est de l'île Melville. Ces deux emplacements n'ont pas été choisis en raison de la proximité du Programme biologique international axé sur le passage Polar Bear dans le premier cas et par suite des coûts de logistique dans le deuxième cas.

Les données de l'étude signalent une incompatibilité avec les renseignements présentés sur les cartes de l'*Atlas hydrologique*. Les taux de ruissellement et de sédimentation sont plus élevés que ceux de l'Atlas. Sans doute, la base de données utilisée dans l'Atlas pour ces deux paramètres est insuffisante pour les îles de l'Arctique et les cartes ne permettent pas de comparer les données relativement médiocres sur le Nord avec les bonnes données pour le Sud. L'utilisation du nivomètre de Nipher sur les terres arides sous-estime les chutes de neige de façon constante. Dans la région de la baie Resolute, la comparaison des résultats des prélèvements et des données des nivomètres de Nipher présente une

marge d'erreur de deux facteurs. Le taux de sublimation de la neige est un des éléments importants du bilan hydrique dans le Nord, quoiqu'il puisse être omis du bilan annuel si l'équivalent en eau de la neige est mesuré juste avant le ruissellement et après les grandes périodes d'insolation de mai et juin, soit lorsque le taux de sublimation est plus élevé. L'évaporation, la condensation et la précipitation peuvent alors être considérées comme ayant une tendance à s'annuler l'un l'autre.

SESSION 10A - DISCUSSION SUR LA FONTE DES NEIGES

P. Baracos

Résumé

Le ruissellement engendré par la fonte des neiges constitue le plus gros du débit annuel dans le Nord. La prévision des taux de ruissellement et de leur distribution temporelle peut s'obtenir en mesurant les quantités de neige et en établissant des modèles de fonte des neiges. Les prévisions ainsi obtenues sont importantes pour la mise en valeur des ressources en eau, l'évaluation des répercussions environnementales, le calcul des données hydrométriques non disponibles et la mise à jour des archives.

Les nivomètres du SEA sous-estiment les chutes de neige sur les terres arides et recueillent trop peu de neige dans les endroits exposés aux rafales. Les relevés nivométriques entrepris avant la période de ruissellement fournissent des données pertinentes sur l'équivalent en eau si les lignes de prélèvement de neige sont représentatives des surfaces du bassin. Les modèles de fonte des neiges peuvent être explicites ou implicites et se fondent sur des paramètres météorologiques dans un modèle d'équilibre de chaleur ou sur des paramètres à fins particulières dans des modèles empiriques de régression simple. La conception des modèles stochastiques comprend trois étapes: 1) l'identification du meilleur type de modèle, 2) l'évaluation des paramètres du modèle et 3) la vérification diagnostique. Les nouveaux programmes d'ordinateur en facilitent la conception. L'analyse des interventions avec ces modèles stochastiques va devenir un outil des plus utiles dans l'évaluation des répercussions. Un modèle de transfert des fonctions pour rattacher la série des durées de ruissellement à la précipitation et à la température est actuellement en voie de développement pour le modèle implicite de fonte des neiges. Le <<Akaike Information Criterion>> constitue un critère utile et objectif dans la sélection des modèles et permet de prendre en considération l'exactitude des statistiques et la simplicité des modèles.

Discussion

Les modèles sont très utiles pour prévoir les événements inhabituels tels que les inondations. Le modèle Box-Jenkins aurait pu par exemple décrire la fonte des neiges de façon beaucoup plus précise que les modèles qui ont servi dans l'étude du ruisseau Snowbird. L'acquisition des données hydrologiques

dans l'Arctique parvient juste à s'échelonner sur la période d'observations recommandée pour la mise en modèle; 17 stations ont à présent emmagasiné des données s'étendant sur la période de 10 ans proposée. Les modèles d'analyse des interventions servant à évaluer les répercussions environnementales sont tout aussi importants après l'aménagement, car ils permettent de déterminer avec précision les impacts. Somme toute, il faut procéder à la cueillette des données avant, durant et après la mise en valeur afin de pouvoir les comparer aux paramètres de base décrivant l'état naturel. À titre d'exemple, lorsque la compagnie Reed Paper a été poursuivie en justice, il n'a pas été possible d'établir les niveaux de contamination de Hg avant la mise en valeur. N'ayant pas de données à l'appui pour prouver que l'usine à papier avait contribué à la contamination des eaux, le plaidoyer n'a pas été convaincant. Les statistiques traditionnelles exigent que tout écart dans les données soit considéré comme indépendant. Puisque la plupart des données d'essai étaient à auto-corrélation dans le présent cas, les essais normalisés n'ont pas pu être utilisés. À partir des techniques d'auto-régression qui éliminent la corrélation, il est possible d'avoir recours aux essais normalisés et d'établir des seuils de confiance pour les données en cause. Une telle analyse va sans doute être utile dans l'évaluation de l'impact suite à son apparition.

SESSION 10B - SIMULATION DE L'ÉCOULEMENT: RIVIÈRE FALLS, ÎLE ELLESMERE (T.N.-O)

D.C. Ambler

Résumé

En 1973, le Groupe de recherches sur les mers gelées du SPM à Victoria a déterminé un critère permettant d'évaluer l'apport d'eau douce aux eaux du fiord d'Iberville. Il a alors demandé à la DRHC à Halifax d'élaborer un programme de trois ans, soit de 1973 à 1975, visant la cueillette des données pertinentes. Un petit bassin à proximité du camp de base, 80° 37' N. et 79° 45' O., a été retenu pour l'étude. Le programme de jaugeage des cours d'eau dans le bassin de la rivière Falls, qui mesure 29,5 km^2, a été intégré au modèle de bassin versant conçu par le <<SSAR>> pour s'adapter aux paramètres spécifiques du bassin. La conception des modèles de simulation de l'écoulement à partir des données sur les chutes de pluie et la fonte des neiges dans les régions de pergélisol, est importante s'il faut établir des évaluations préliminaires sur l'impact hydrologique qu'auront les nouveaux aménagements dans le Nord. Les données d'entrée du modèle portent sur les paramètres physiques fixes, sur les conditions hydrologiques initiales et sur les variables temporelles telles que la précipitation, la température ambiante et la fonte des neiges. Pour simuler les débits d'étiage vers la fin de l'été, il a fallu inclure dans le modèle le débit des eaux souterraines, ce qui paraît invraisemblable pour une région pergélisolée. Cette démarche s'est imposée en raison des hypothèses initiales formulées dans la simulation. Même si ce premier modèle ne permet pas de prévoir les débits quotidiens de façon précise, la technique peut éventuellement être utile pour les recherches entreprises dans le Nord canadien.

Discussion

L'emmagasinage provisoire des eaux derrière les barrages de neige ne semblait pas sérieusement toucher au processus d'écoulement de la rivière Falls. La simulation initiale n'a pas produit les résultats escomptés. L'analyse des erreurs dans les données d'entrée est donc nécessaire. Une bonne simulation doit vraisemblablement fournir des données se trouvant à 10 % près des données mesurées. Le paramètre le plus sensible semble avoir été l'indice de l'humidité du sol. Même si l'extrapolation des données aux bassins non étudiés doit se faire avec un grand soin,

elle fournit suffisamment de renseignements hydrologiques pour assurer la préparation des énoncés sur l'environnement. Il est encore trop tôt pour savoir comment le modèle va réagir aux modifications des paramètres physiques engendrées par les activités de l'homme dans le bassin.

SESSION 11 - DONNÉES DE LA DGEI ET EXPERTS-CONSEILS

C. Templeton

Résumé

L'évaluation des répercussions vise la protection de l'environnement. Pour réaliser cet objectif, les quatre étapes consistent à:

1. Appuyer les personnes chargées de prendre les décisions sur la faisabilité du projet, sur le lieu d'aménagement et sur la manière de procéder.

2. Établir les modalités et les conditions afin de s'assurer des impacts.

3. Contrôler et surveiller le projet.

4. Évaluer le projet après sa construction.

Les données de base essentielles à chaque étape varient.

L'évaluation des répercussions des pipelines proposés de la baie Prudhoe et du delta Mackenzie est examinée avant tout en fonction des données requises et des données utilisées dans la première étape (à savoir les données facilitant la prise de décisions).

La route du pipeline du delta du Mackenzie est comparée avec la route de l'Alaska en termes numériques et le facteur <<eau>> fait l'objet d'une discussion pour démontrer son importance relative par rapport aux autres éléments et à la décision finale.

La discussion a cherché à répondre aux questions suivantes: Qui doit fournir les données de base? Qu'est-ce qui est requis? Comment les experts-conseils doivent-ils présenter leurs opinions et recommandations sur les évaluations des répercussions?

Discussion

L'échange technologique entre les secteurs public et privé a été fructueux. Il faudrait toutefois améliorer la communication au niveau de la création des politiques et de la planification. Le secteur public possède une meilleure organisation scientifique et en travaillant ensemble il serait possible d'optimiser l'évaluation des répercussions. Dans le processus d'évaluation environnementale,

les fonctionnaires fédéraux défendent maintenant les deux côtés des cas présentés en témoignant pour la défense et la commission, ce qui entraîne une perte de crédibilité. Les modalités et les conditions détaillées, qui sont en vogue de nos jours, ont une valeur contestable. En effet, elles nuisent probablement au développement puisque les perceptions et intérêts changent au fur et à mesure que les données de base s'accumulent. Toute prise de décisions exige nécessairement une vue d'ensemble. Il faut considérer que de telles présentations sont presque entièrement subjectives, donc sujettes à une mauvaise interprétation. La meilleure description des points saillants du problème s'effectue en se servant de rapports et brochures bien illustrés. L'importance des photographies pour compléter le matériel écrit a été démontrée dans le dernier rapport Berger - un livre à succès.

SESSION 12 - PRÉSENTATION DU BFERE

P.G. Wolf

Thème suggéré

Discussion traitant de PERE et ayant pour objet:

- les besoins d'informations, la façon de les déterminer et de les soumettre à la DGEI,
- les mécanismes permettant d'intégrer l'information pertinente aux énoncés des répercussions environnementales et
- le rendement de la DGEI à cet égard.

Au même titre, appréciation portant sur:

- les leçons retenues jusqu'à date et
- les moyens d'améliorer l'évaluation des répercussions environnementales.

Plan

Examen des questions susmentionnées à partir des catégories suivantes:

1. PERE.
   - discussion fondée sur une transparence du diagramme de cheminement
2. Étude des besoins d'informations en fonction des diverses sources au sein du processus (diapositive du diagramme de cheminement).
3. Division des tâches.
   - PERE
   - Commission
   - BFERE
   - MPE
4. Tâches du personnel du MPE (DGEI) dans le processus.
   - examen d'une transparence illustrant les éléments d'interaction.

   (Si le temps est limité, cet aperçu peut être distribué avant le début des questions.)

FONCTION	REQUÊTE/ INITIATEUR	TECH. INDIVIDUEL (EXPERT)	GROUPE DE TRAVAIL	SERVICE DU MINISTÈRE	MINISTÈRE	COMMENTAIRES
A. GÉNÉRALITÉS						
EXPERT TECH.	INDUSTRIE	X				
	MINISTÈRES GOUV.	X				
	CRSC	X				
	BFERE	(X)				
PRÉPARATION DES DIRECTIVES	COMMISSION (BFERE)	X	(X)	X		Du BFERE → au président du comité régional → au CRSC
MEMBRE DE LA COMMISSION	COMMISSION (BFERE - SM)	X				
RENSEIGNEMENTS ET CONSEILS	INDUSTRIE	X	(X)	X		
	MINISTÈRES GOUV.	X		X		
	CRSC	X	(X)			
	BFERE	(X)			(X)	
CONCLUSIONS DE L'ERE	COMMISSION (BFERE)	X →	(X) →	X →	X →	Il s'agit d'une chaîne
- INTERVENANT	SM/SMA			(X)	X	(elle dépend des étapes antérieures)
DONNÉES DE BASE	SM MINISTÈRES GOUV.	X	X	X	X	
B. PARTICULARITÉS						
SURVEILLANCE	RAPPORT	X		X		Responsabilité du Ministère
CONTRÔLE	RAPPORT	X		X		Responsabilité du Ministère

NOTE: Le X entre parenthèses indique une possibilité peu fréquente

SESSION 12 - PRÉSENTATION DU BFERE

P.G. Wolf

Discussion

L'acquisition des données de base hydrologiques a coïncidé avec la tenue d'audiences sur la mise en valeur du Nord canadien.

La région de l'Ouest et du Nord avait désigné les organismes directeurs chargés de coordonner la planification des programmes de base. En participant à la commission, les fonctionnaires fédéraux ont consacré au travail beaucoup de temps qui a été perdu aux mains de l'agence de soutien. La pénurie de spécialistes dans maints domaines physiques et biologiques a entraîné le surmenage de certains chercheurs. Dans certains cas, les membres de la commission ont perdu le droit d'abstention par suite de décisions politiques, par exemple lors des audiences sur l'Alcan. Aucune ligne de conduite écrite n'existe actuellement au sein de la commission. De telles directives pourrait intimider beaucoup de participants, transformer les audiences en un processus quasi-judiciaire et établir des précédents pouvant engendrer des disputes légales. Les problèmes inhérents de cette approche <<officieuse>> qui se font le plus sentir à Vancouver, sont les délibérations sur la procédure à suivre et la question sur l'efficacité de chaque audience particulière. Les commissions doivent utiliser toute l'information qui leur est fournie lors de la tenue des audiences, en dépit des intérêts personnels. Malheureusement, il y a eu des exceptions à cette règle.

SESSION 13 - PROGRAMMES ACTUELS ET NOUVELLES EXIGENCES DANS L'ÉVALUATION DES RÉPERCUSSIONS ENVIRONNEMENTALES

J.E. Slater

Résumé

Deux présentations récentes à la haute direction de la DGEI par des spécialistes renommés en hydrologie et en géomorphologie, maintiennent que les programmes traditionnels de la DRHC ne peuvent pas fournir assez de données scientifiques pour assurer une bonne évaluation des répercussions. Il faut que les programmes additionnels dans le Nord traitent de la qualité des eaux et de la sédimentation. La recherche sur les petits bassins, qui porte sur les aspects hydrologiques reliés aux différences morphologiques régionales, soutien que des modifications majeures dans les réseaux actuels de la DRHC sont de mise. Le personnel responsable n'a pas la capacité d'effectuer seul ce travail; il lui faudra l'appui d'autres organismes de recherche au sein du MPE. De plus, l'exploitation d'un réseau de base dans le Nord, soit jusqu'aux îles, est essentielle afin de pouvoir répondre scientifiquement aux questions qui se posent aujourd'hui.

Pris ensemble, la mise en valeur des réseaux et des lignes de base représentent une nouvelle mise de fonds substantielle. En vertu des restrictions actuelles, il se peut fort bien que les fonds requis vont provenir de la réduction des dépenses des programmes actuels. En termes de données sur la qualité des eaux, le besoin le plus urgent est d'établir un ensemble de normes pour le prélèvement, la préservation et l'analyse des échantillons, qui permettraient de comparer et d'intégrer les résultats obtenus par les différents organismes. Ceci n'est pas possible avec les données produites à l'heure actuelle.

Discussion

Il faut que les réseaux soient définis en termes de zones hydrologiques et géomorphiques homogènes afin de pouvoir procéder avec confiance à l'extrapolation des données obtenues. Pour ce qui est des paramètres rattachés à la qualité des eaux comme la chimie des principaux ions, le présent concept s'applique; toutefois, il ne peut pas servir à déterminer les taux de substances nutritives et de toxicité. Les programmes à long terme sur les propriétés chimiques de l'eau ne sont pas vraiment nécessaires, ce qui est également vrai pour maints aspects des programmes de sédimentation.

Les groupes de travail et de recherche au sein du MPE doivent communiquer plus étroitement s'ils veulent améliorer leurs rapports. Le rassemblement des paramètres de nouvelles données pour les emplacements du Nord établis par la DRHC va entraîner une hausse des coûts et le capital requis ne semble pas être disponible à présent. Il faut peut-être que la DRHC s'oriente vers la cueillette des données permettant de tracer des courbes de fréquence et de décrire les phénomènes particuliers dans le Nord plutôt que de se limiter à l'enregistrement des débits quotidiens. À cet égard, la mise en modèle du débit des cours d'eau peut être pratique. Une nouvelle technologie doit être mise sur pied pour mesurer les débits de pointe lorsque la glace est présente. Les recherches de la Division de la glaciologie sur le Mackenzie ont présenté une technique photogrammétrique pour définir la vitesse en surface lorsque l'eau est soumise aux effets de la glace en déplacement. En se servant conjointement de ces renseignements et des mesures effectuées à partir d'une embarcation, il est possible de déterminer les débits de pointe lors des périodes de glace.

SESSION 14 - BESOIN DE FORMATION DU PERSONNEL -
COORDINATION DE LA RECHERCHE DES ORGANISMES

H. Eisenhauer

Résumé

L'atelier traite de l'approche adoptée par la DGEI pour l'acquisition des données dans le Nord, qui va lui permettre d'apporter des commentaires autoritaires sur l'énoncé des répercussions environnementales pour le Projet de pipeline des îles de l'Arctique. Ce travail a mis en lumière une lacune de connaissances et un besoin de formation. La recherche pour acquérir de nouvelles connaissances et les programmes de formation pour répondre aux exigences de la DGEI lui permettront de recueillir et d'interpréter plus efficacement les données requises pour de tels ouvrages à l'avenir. La présente session vise l'identification et l'élaboration des besoins de formation et de recherche pour évaluer les répercussions environnementales dans le Nord. La discussion peut être entamée à partir des quelques sujets suivants:

Besoin de formation

1. En raison des dépenses de déplacement du personnel dans les régions éloignées du Nord, il est préférable de rassembler autant de renseignements que possible sur place. Les techniciens peuvent être tenus de rassembler des données avec lesquelles ils ne sont pas familiers. Il devient donc nécessaire de prévoir la formation des techniciens pour leur permettre d'évaluer, par exemple, les caractéristiques géomorphiques des bassins hydrographiques du Nord.

2. Pour des raisons analogues, les techniciens de la DRHC chargés de prélever et de préserver les échantillons d'eau doivent recevoir une formation particulière afin que les échantillons à doser soient représentatifs et homogènes.

Besoin de recherche

Le besoin de recherche appliquée fondée sur des problèmes spécifiques a déjà été identifié dans les documents de référence. Les discussions ont souligné d'autres besoins plus généraux et plus vastes. Il s'agit, entre autres, de:

1. Élaborer une méthodologie pour définir la quantité minimale de renseignements permettant une prévision juste des effets probables d'un projet donné sur l'environnement.

2. Établir une méthodologie pour déterminer l'exactitude d'une évaluation des répercussions environnementales fondée sur des données de base restreintes.

3. Identifier le genre de renseignements nécessaires à l'évaluation des répercussions environnementales dans le Nord.

4. Identifier les types spécifiques de bassins sur lesquels seront axés les programmes d'acquisition des données.

5. Concevoir des modèles particuliers pour les bassins de l'Arctique qui prendront en considération les effets uniques du pergélisol et de la couche active.

Tout commentaire sur les sujets proposés ou sur un autre aspect de la question en cause est apprécié.

Discussion

Les membres du Comité consultatif de la recherche sur l'eau se réunissent deux fois l'an pour dresser la liste des priorités des projets de recherche. Les directeurs régionaux prennent part aux décisions. Ce processus permet d'établir une voie de communication entre les groupes de travail et de recherche au sein du Ministère. L'INRE de la région de l'Ouest et du Nord est soumis à des contraintes rigoureuses quant aux fonds disponibles et aux années-hommes. Afin de favoriser la recherche, il va sans doute falloir remanier les programmes existants. Le MPE fait actuellement face à une situation intenable en ce qui concerne le processus d'évaluation des répercussions. L'exercise d'une option d'abstention dépend de l'entrée fournie par le MPE. Les scientifiques oeuvrant au sein du gouvernement se sentent obliger de prendre des décisions et de porter des jugements sur les répercussions environnementales même lorsque les données sont insuffisantes sur le plan scientifique. C'est en quelque sorte une forme de prostitution des principes scientifiques. S'ils sont établis, les critères d'évaluation des répercussions environnementales auront tendance à aggraver la situation. Les solutions les plus pratiques semblent être de convaincre le BFERE du besoin de recueillir de plus amples données, de refuser d'apporter des commentaires en raison de données inadéquates, de définir les niveaux d'incertitude par rapport aux données et conclusions contestables ou de détourner le processus de la commission en présentant directement les recommandations au Ministre.

Peu importe la procédure suivie par la communauté scientifique, le public doit être informé du fait lorsque les données ne sont pas appropriées à la prise de décisions rendue public. Certaines améliorations à la base de données peuvent être effectuées en rassemblant des renseignements qualitatifs pour d'autres organismes. Même si de telles données ne sont pas nécessairement d'un calibre élevé, leur utilisation judicieuse peut être très profitable. Le besoin de formation entre les organismes, la planification coordonnée et la surveillance étroite sont des étapes indispensables. Des économies à l'échelle peuvent être réalisées en intégrant les camps éloignés, les cachettes de carburant, etc. Des camps de base communs peuvent également faciliter la cueillette des données entre les différents organismes.

SESSION 15 - CONCLUSION

D. Kerfoot

Les termes de référence de l'atelier ne semblent pas avoir été suffisamment explicites pour certains participants. Maintes présentations ont traité des données ou des renseignements, mais aucune ne s'est penchée sur la technologie se rapportant à l'évaluation des répercussions environnementales.

Il est facile de s'écarter de l'objectif du processus d'évaluation. En somme, celui-ci vise à évaluer avec exactitude les effets probables d'un aménagement sur l'environnement naturel. Le rôle des scientifiques fédéraux dans le processus n'est pas de prendre des décisions, mais bien davantage de présenter des recommandations fondées sur leur interprétation des répercussions environnementales du projet en cause. De telles recommandations sont alors examinées en fonction de plusieurs disciplines et éventuellement sont traduites dans la décision finale. On s'écarte de la perspective en interprétant mal l'importance des intérêts spécialisés. Selon Carson Templeton, ces intérêts ne correspondent qu'à 2,5 % du total. À cause de cette perspective, on doit ré-examiner la répartition des fonds destinés à l'évaluation environnementale.

Le processus d'évaluation doit faire face à un autre problème, soit sa crédibilité limitée dont le blâme peut être partiellement attribué au BFERE. La position traditionnelle du Ministère, qui a été de rechercher le déploiement de ressources à des niveaux inaccessibles, a aussi nuit à cette crédibilité. Par exemple, la recherche environnementale dans la vallée du Mackenzie qui a fait l'objet de dépenses se chiffrant dans les millions de dollars par l'industrie, les services scientifiques du gouvernement et la Commission d'enquête Berger, semble maintenant avoir été mal dirigée puisque les deux facteurs responsables de l'annulation du projet étaient déjà connus, à savoir la sensibilité des terrains dans le Nord et le problème des troupeaux de caribous à Porcupine.

Une contribution au processus est d'élaborer des directives pour identifier les genres de problèmes qui doivent être résolus par le défenseur. L'établissement des directives doit se faire avec soin; une série de directives trop générales tend à fournir des rapports subjectifs de la part de la Direction générale, c'est-à-dire des rapports qui n'impliquent aucune recherche et qui donnent une fausse image du Ministère.

Une deuxième contribution se rapporte à la révision de l'énoncé des répercussions par la commission. Maints problèmes à cette étape du processus relèvent de la quantité de renseignements requis, qui est généralement inférieure aux exigences du spécialiste. Il faut se pencher sur les préoccupations qui vont influencer la décision d'acceptation ou de rejet et non pas évaluer les détails de conception et les problèmes techniques. Lorsque les directives exigent de telles données précises, comme dans le cas du système de rassemblement des gaz dans le delta du Mackenzie alors que le projet n'était qu'à l'étape de conception, le processus s'écroule parce qu'aucune réponse ne peut être fournie à ce niveau d'expertise.

Une autre contribution est possible à l'étape de la révision de la conception en ayant recours à une autorité réglementaire nouvellement formée ou aux groupes existants comme les comités sur l'eau ou les comités d'utilisation des terres. Il s'agit là d'un type de révision employé pour les routes de Dempster, du Mackenzie et de Liard, où le public a joué un rôle plus limité que dans les projets du BFERE. Ces révisions ont permis de modifier certains détails comme la grosseur des ponceaux, la conception des routes et les tracés proposés. Les résultats ont été aussi significatifs qu'aurait pu être le processus hautement visible du BFERE, en autant que la décision d'acceptation ou de rejet avait déjà été prise à l'échelle politique.

La participation du MPE dans les processus de révision a créé des problèmes de temps, de travail et de budget. Le développement d'une expertise à l'intérieur des cadres pour permettre au MPE de prendre une position indépendante dans le processus de révision est un luxe qu'on ne peut pas se payer. L'attitude crée une répétition de l'effort entre les programmes privés des défenseurs et les efforts du gouvernement. De tels programmes peuvent bien être perçus comme des défis implicites à l'intégrité et à la compétence du défenseur et de ses experts-conseils.

Premièrement, pour faciliter le travail, il va falloir établir les vrais besoins de données. Les inventaires et les listes actuelles ne sont pas pratiques puisque très peu de ces données sont utilisées dans les processus d'évaluation. Les données servent le mandat des organismes, mais portent très rarement sur les problèmes posés par la révision des énoncés des répercussions. Si les services gouvernementaux étaient suffisamment responsables de l'élaboration des exigences de renseignements et s'ils avaient à répondre à des questions comme "Qu'est-ce que vous voulez vraiment savoir?", "Pourquoi voulez-vous le savoir?" et "Comment proposez-vous d'utiliser de tels renseignements?", le gouvernement pourrait mieux résoudre les problèmes de temps, de travail et de fonds disponibles.

Deuxièmement, il faut se pencher sur la quantité de renseignements qu'un scientifique aimerait avoir en sa possession avant de prendre une décision et il va de soi qu'il aimerait en avoir plus que moins. Puisque la plupart des décisions d'évaluation reviennent finalement au spécialiste, le besoin le plus pressant, dans le contexte actuel, est de le convaincre de prendre des décisions en se basant sur une plus petite quantité de données. Cette approche fondée sur le bon sens n'est pas si mauvaise et est tout aussi pratique que les principes scientifiques de base. Les politiciens, eux, prennent des décisions en ayant recours à des critères d'acceptabilité politique beaucoup plus subtiles, donc la communauté scientifique ne serait pas la seule à adopter des normes beaucoup moins rigoureuses.

En troisième lieu, le travail engendré par l'évaluation environnementale peut être réduit si la DGEI coordonne davantage les activités et l'échange de renseignements entre les groupes de recherche et de travail. L'administration centrale peut être chargée de cette coordination afin d'assurer l'efficacité, la convenance et l'uniformité des programmes à l'étude.

Finalement, il faut développer une certaine expertise dans l'art de la vente afin de créer un intérêt pour les projets à long terme dans le Nord. Du point de vue du mandat de la DGEI, l'expansion du réseau hydrologique en direction du nord est évidente. Si la haute direction pouvait être convaincue de l'utilité de nouvelles stations polyvalentes pour évaluer les répercussions environnementales, il serait probablement possible de réaliser un plus grand nombre d'objectifs. À cet égard, il faut mettre plus d'emphase sur la valeur des études de bassins. Si elles sont effectuées à proximité de l'aménagement proposé, ces études vont permettre à la DGEI de remplir son mandat pour les réseaux, de traiter des effets probables et d'établir des prévisions ou des modèles pour l'extrapolation. Cette approche va augmenter les chances de succès de la mise en valeur du Nord. Un autre point de vente à considérer pour les travaux éventuels correspond au besoin d'évaluer les prévisions des répercussions qui ont déjà été ou qui seront formulées d'ici peu. Ceci ne s'est pas encore produit au Canada, mais il s'agit là d'un besoin qui est clairement perçu. Il faut aller de l'avant pour déterminer jusqu'à quel point les prévisions étaient justifiées, quel était leur degré de précision et jusqu'à quelle limite elles peuvent être décomposées pour en faire ressortir les indices clés. Ce travail va servir aux nouveaux projets. Le programme de base à long terme est un élément supportant efficacement l'évaluation des répercussions environnementales, s'il est mis en oeuvre de façon judicieuse, et il doit être présenté à la haute direction du MPE comme un article à grande priorité. Le SMA est en faveur de cette approche et de ce genre de travail.

Les activités connexes existantes mettent en lumière la situation. Le rapport entre le MPE et le BFERE est à l'étude, ce qui va permettre de définir plus précisément les rôles individuels, c'est-à-dire quand les spécialistes parlent-ils au nom de la communauté scientifique et quand représentent-ils le Ministère. La séparation ministérielle qui a produit le ME et le MP et la répartition des responsabilités pour l'évaluation de l'environnement ne sont pas encore résolues.

Somme toute, une proposition pour établir un programme d'études de base est actuellement à l'étude. Le programme se fonde sur l'apport régional et l'aménagement prévu et il identifie les thèmes communs, les régions identiques et les foyers d'intérêt qui vont éventuellement faciliter l'évaluation de l'aménagement. Même si ce programme est très avantageux, sa mise en application peut entraîner une redistribution des fonds des programmes actuels.

Le présent résumé traite de quelques points soulevés au cours de l'atelier et de quelques-uns faisant l'objet de commentaires personnels. D'une manière générale, ils sont fonction des activités connexes du Ministère et dépendent, dans une large mesure, d'une analyse approfondie des travaux et de la coordination au sein du Ministère.

Discussion

Il semble exister trois niveaux d'exigences de données, le niveau le plus bas étant celui de l'évaluation des répercussions environnementales.

En établissant le Projet de pipeline des îles de l'Arctique pour obtenir des renseignements, on savait que les modalités et les conditions devraient être élaborées prochainement, travail qui exige un plus haut niveau de renseignements. En outre, la DGEI est responsable de la cueillette à long terme des données sur les ressources en eau, en vertu de son mandat. Les données disponibles sur cette région étaient trop limitées pour répondre à ces besoins divers.

Puisqu'on est responsable de l'acquisition des données, on a cru qu'il fallait rassembler autant de renseignements que possible. Il est vrai que seulement une certaine partie des renseignements s'applique directement aux énoncés des répercussions. Par contre, le reste peut répondre aux exigences des autres niveaux susmentionnés. En tenant compte de ces considérations, il est évident que certaines des ressources qui ont servi à la cueillette des données ne relevaient pas directement des énoncés sur les répercussions; cependant, les données recueillies vont servir

dans une phase éventuelle du processus. Dans cette perspective, la DRHC a tiré parti des circonstances.

Il ne s'agit à présent que d'appliquer l'expertise technique et scientifique à l'étude de la proposition et de déterminer si celle-ci s'adapte aux renseignements généraux déjà recueillis. Il faut, entre autres, établir si la solution proposée et les données obtenues allègent les inquiétudes manifestées lors de l'évaluation initiale des répercussions.

SESSION 16 - ÉVALUATION DE L'ATELIER

H. Eisenhauer

Chaque participant a reçu une formule lui permettant d'évaluer les travaux de l'atelier et de faire part de ses commentaires aux organisateurs. Les 22 formules qui ont été retournées représentent une réponse par plus de 50 % des participants, ce qui est relativement élevé. Les critiques ont été analysées comme suit.

1. Installation

La pièce consacrée à l'atelier était aménagée comme une salle de classe, avec sept rangées de sept tables et chaises à rotule du genre ancré et faisant face à la plate-forme légèrement surélevée à l'avant. Cette plate-forme de «lecture» comprenait un lutrin, des tables, un projecteur surélevé et un écran. Le lutrin et chaque table étaient aménagés avec des microphones. Les diapositives qui étaient projetées depuis une salle de projection à l'arrière pouvaient être changées à volonté par le conférencier au lutrin. Les débats ont été enregistrés sur un enregistreur à cassette.

Tous les répondants, à l'exception d'un seul, ont affirmé que la pièce était de grandeur suffisante, mais un tiers a trouvé que la disposition des chaises était insatisfaisante, et plusieurs ont suggéré qu'elle était trop formelle pour entraîner des dicussions spontanées. Un nombre de répondants ont proposé que les participants devraient se faire face pour faciliter les discussions; un arrangement selon un plan circulaire, rectangulaire ou en U serait à souhaiter. Un répondant a noté qu'il était très avantageux d'avoir des tables. Tous ont été d'accord pour dire que l'équipement audio-visuel était satisfaisant.

2. Format

L'atelier comprenait cinq demi-journées de sessions consacrées à différents aspects de l'évaluation des répercussions environnementales dans le Nord. Les deux ou trois thèmes connexes dans chaque session ont été introduits par des conférenciers du podium. Après la présentation, on invitait les participants à discuter chaque thème. Le temps accordé à chaque thème variait de 45 à 90 minutes, avec un tiers du temps consacré à la présentation et le reste, aux discussions. Les présidents des sessions devaient guider les discussions et

voir à ce que leurs sessions se déroulent en deçà du temps permis. Une pause café d'environ 15 minutes était prévue après la moitié de chaque session. Une réception non officielle (un vin et fromage) s'est tenue le premier soir.

Vingt-et-un répondants ont attesté que le nombre de thèmes était suffisant pour l'élaboration du sujet alors qu'un participant a signalé qu'il en aurait fallu plus. Des répondants, 15 % ont maintenu que les présentations étaient trop formelles alors que le reste les ont trouvé satisfaisantes. Même si la plupart des conférenciers ont dépassé le temps alloué de 50 à 100 %, tous les répondants, à l'exception d'un seul, ont affirmé que la durée des présentations était satisfaisante.

Chacun a convenu que la tenue des discussions après les présentations était de mise, mais une personne sur six a témoigné que les périodes consacrées aux discussions n'étaient pas suffisantes. Une personne a recommandé la tenue d'une discussion générale supplémentaire après chaque session d'une demi-journée. Un tiers a cru que les discussions n'entraînaient pas assez d'interaction et de spontanéité. Les raisons menant à cette conclusion comprennent:

- la grande variété des thèmes abordés qui ne touchaient pas nécessairement tous les participants;

- les participants qui étaient trop nombreux;

- la disposition de la pièce qui ne favorisait pas les discussions;

- les présidents des sessions qui ne connaissaient pas assez les participants pour demander à des personnes spécifiques d'apporter leurs commentaires.

Un répondant a suggéré que la situation pouvait être améliorée en divisant l'atelier en plus petits groupes de discussion, chaque groupe traitant d'une gamme de thèmes plus restreinte et se rattachant directement aux participants du groupe. Un autre a recommandé que le programme soit structuré pour assurer une mise en évidence et une concentration des thèmes à discuter. Un troisième a proposé que des personnes spécifiques soient approchées pour apporter leurs commentaires de manière à les faire participer à la discussion.

Tous les répondants ont convenu que la majorité des présidents de sessions avaient stimulé les discussions de façon satisfaisante. L'intérêt aurait été accru toutefois si les présidents avaient mis en lumière les points saillants de chaque présentation et s'ils avaient apporté leurs propres commentaires, incité des personnes spécifiques à formuler leurs suggestions et orienté la discussion sur le besoin d'échange technologique pour le sujet traité. Un répondant a proposé que l'utilisation de cartes de <<commentaires>> aurait permis aux présidents d'organiser la discussion autour des foyers d'intérêt . Une des recommandations a souligné que le président d'une session pourrait rencontrer les conférenciers avant la session pour assurer une meilleure coordination de la présentation et de la discussion. Une personne a affirmé que les présidents des sessions devraient se familiariser avec le sujet à l'étude; il a trouvé que les présidents étaient à la hauteur de la situation dans le cas présent.

De ceux qui ont participé à la soirée sociale, tous sauf deux ont indiqué qu'elle avait permis de se connaître et de stimuler des discussions fructueuses et sans cérémonie. Chacun a cru que les pauses cafés étaient assez nombreuses et qu'assez de temps avait été prévu à cette fin. Deux personnes ont estimé que les pauses cafés étaient trop courtes, une des deux a suggéré qu'une pause café plus longue permettrait aux participants de se mieux connaître et leur laisserait plus de temps pour discuter de thèmes qui les intéressent. (Soit dit en passant que ce dernier répondant n'était pas présent au vin et fromage.)

3. Matériel

L'atelier technique devait améliorer l'échange de la technologie entre ceux qui la conçoivent (ordinairement, mais pas essentiellement, les chercheurs dans la DGEI et ailleurs) et ceux de la DGEI qui l'utilisent, soit le personnel oeuvrant sur les lieux ou en laboratoire. Le premier objectif vise à améliorer la capacité de la DGEI pour qu'elle puisse remplir ses responsabilités opérationnelles. Le deuxième objectif vise à identifier les lacunes dans les connaissances qui vont exiger des recherches plus poussées. Le premier objectif, par rapport au sujet traité, n'a pas été assez évident pour 40 % des répondants, probablement parce que la plupart des sessions semblaient être plus orientées sur le partage des renseignements et de l'expérience que sur l'échange de la technologie. En outre, un tiers des répondants ont ressenti que l'atelier n'avait pas atteint son objectif de la façon qu'ils le percevaient, même si plusieurs ont témoigné qu'il avait été un succès jusqu'à un certain point, dans la mesure

où ceux qui ont travaillé dans le Nord ont partagé leurs connaissances techniques avec ceux qui se proposent d'y travailler dans le futur.

La moitié des répondants ont indiqué que l'atelier n'avait pas englobé le sujet de façon adéquate. Selon plusieurs d'entre eux, la plupart des présentations se concentraient essentiellement sur les méthodes de rassemblement des renseignements plutôt que sur les moyens d'utiliser de tels renseignements pour évaluer les répercussions environnementales. En effet, seulement 70 % des répondants ont témoigné que les thèmes choisis se rapportaient au sujet. Un répondant a estimé que l'examen des propriétés chimiques des eaux était hors de propos. D'un autre côté, une personne a signalé qu'il aurait fallu mettre plus d'emphase sur les aspects de la qualité des eaux. Les thèmes avaient été choisis par les directeurs de la DGEI, à partir d'un programme proposé par les organisateurs de l'atelier. Personne n'a formulé de suggestion positive pour améliorer le processus de sélection.

Les organisateurs de l'atelier ont demandé à tous les conférenciers de leur remettre des présentations ou des documents de référence afin d'en assurer la distribution bien avant la tenue de l'atelier. En raison des délais inévitables dans la réception des rapports et par suite d'une grève des postes, une série incomplète a été distribuée aux participants seulement quelques jours avant l'atelier. Il n'est donc pas surprenant qu'un tiers des répondants ont été d'avis que les renseignements préliminaires n'étaient pas suffisants et qu'un quart a estimé que les thèmes n'avaient pas été traités de façon adéquate. Par ailleurs, 80 % des répondants ont signalé que les renseignements préliminaires étaient utiles et même <<absolument nécessaires>> dans un cas. Un autre participant a recommandé que les documents envoyés par la poste devraient renfermer des renseignements sur le but et les objectifs de l'atelier ainsi que des informations sur les dispositions prises.

Neuf personnes sur dix ont attesté que la plupart des présentations orales étaient adéquates en termes de renseignements fournis et tous ont convenu que le nombre de diapositives était suffisant.

Les comptes rendus de l'atelier, qui comprennent une transcription rédigée des discussions, devaient paraître prochainement. Presque tous les répondants ont confirmé qu'une telle publication suffirait et qu'aucun autre renseignement additionnel ne serait requis.

4. Participants

Les organisateurs ont cru que le nombre de participants à l'atelier devait se trouver entre 40 et 45 au plus, compte tenu des conférenciers. Les directeurs de la DGEI ont dressé une liste des participants et le Comité de direction l'a approuvée. Des répondants, 80 % ont estimé que le nombre de participants était suffisant pour favoriser une atmosphère d'atelier et entraîner une discussion spontanée. Environ 15 % ont témoigné que le nombre de participants était trop grand. Une personne a répondu qu'un plus grand nombre de personnes à formation technique et représentant les Territoires du Nord-Ouest auraient dû être invitées. La moitié des répondants ont signalé que la sélection des participants n'était pas la meilleure possible en fonction des objectifs de l'atelier. Plusieurs de ces derniers ont souligné qu'il aurait mieux valu traiter d'un plus grand nombre de thèmes et avoir plus de chercheurs, de directeurs, de personnes intéressées à la qualité des eaux et de représentants du MAIN. Un autre a noté que les délégués provenant du secteur de la politique et de la planification auraient dû être moins nombreux, avec une plus grande participation des représentants oeuvrant directement dans les domaines faisant l'objet de l'atelier. D'un autre côté, un répondant a indiqué que le choix des participants était <<bon et inclusif>>; un autre a ajouté: <<J'ai été satisfait de la composition mixte des participants, c'est-à-dire des planificateurs des programmes, des responsables de l'acquisition des données, des utilisateurs des données venant de l'industrie et du PERE ainsi que des chercheurs>>.

5. Généralités

En dépit des réserves susmentionnées, tous les répondants ont cru que cette méthode d'échange de la technologie était utile. Plusieurs ont indiqué qu'il aurait été plus juste d'identifier la matière de l'atelier par un <<partage de renseignements>> que par un <<échange de la technologie>>. Une personne a proposé qu'il aurait mieux valu séparer les participants en plusieurs petits groupes pour assurer des discussions techniques en profondeur. Une deuxième a suggéré que l'atelier serait plus réussi s'il était possible de trouver le juste milieu entre une description de la technologie disponible et une identification des besoins technologiques. Une troisième a souligné qu'un transfert de connaissances détaillées s'effectue le mieux de personne à personne. En réponse à la question <<Est-ce que cette méthode d'échange de la technologie est utile?>>, une personne a écrit: <<Définitivement <<OUI>>. Nous avons tenté des conférences, des colloques et

des cours de formation à l'intérieur des cadres fédéraux et à l'extérieur du gouvernement pour renseigner les gens sur ce qui se passe. Ces mesures sont dispendieuses, trop de personnes non spécialisées y prennent part, elles exigent beaucoup de temps et elles n'ont pas obtenu le succès escompté. Ce genre d'atelier offre de grandes possibilités>>.

Environ 90 % des répondants ont trouvé que l'atelier était personnellement utile. Certains ont proposé que l'atelier aurait été plus utile si les thèmes traités avaient été plus nombreux, par exemple, la qualité des eaux. Une personne a souligné que la discussion sur l'évaluation des répercussions et les solutions de rechange n'avait pas été assez approfondie; une autre aurait aimé une discussion plus élaborée sur les problèmes d'exploitation et les solutions possibles.

6. Recommandations

Les participants ont apporté des suggestions additionnelles pour accroître l'efficacité des ateliers de même nature (y compris la matière à l'étude, le format, la discussion, les formalités, le nombre et la représentation des participants, etc.). Les données ci-après résument les recommandations de 13 répondants ainsi que celles formulées dans le corps du présent rapport d'évaluation.

6.1 Installation

Pour animer les discussions, la disposition des sièges devrait être telle que les participants se font face (plan circulaire, rectangulaire ou en U).

6.2 Format

- Prolonger les périodes accordées aux discussions.

- Séparer les participants en plus petits groupes pour la discussion de thèmes connexes au niveau technique et présenter ensuite les résultats à la session plénière.

- Prévoir des périodes pour des discussions non officielles entre les sessions.

- Les présidents des sessions devraient inviter des personnes particulières à apporter leurs commentaires pour faciliter les discussions.

- Suite aux présentations générales, il faudrait considérer l'emploi de discussions non officielles fondées sur des sessions à l'affiche qui accentuent la technologie.

- À la fin de chaque jour, il faudrait étudier les présentations en fonction du sujet de l'atelier.

6.3 Matériel

- Définir la raison d'être et l'objectif de l'atelier de façon plus explicite et s'assurer que son titre réflète véritablement le sujet à l'étude.

- Bien séparer les thèmes de politique de ceux de l'échange de la technologie.

- Les thèmes devraient accentuer <<l'échange de la technologie>> plutôt que de se limiter au <<partage des renseignements>>

- Les renseignements préliminaires devraient renfermer toutes les présentations et être expédiés aux participants bien avant la tenue de l'atelier.

- La correspondance préliminaire devrait comprendre des renseignements sur l'organisation, les dispositions prises et l'orientation de l'atelier.

- Une commission de révision devrait déterminer le rapport des présentations avec le sujet de l'atelier avant qu'elles soient acceptées.

- Une dernière session devrait être dédiée aux utilisateurs de la technologie.

6.4 Participants

- Accroître l'ampleur d'intérêt manifestée par les participants, par exemple inclure un plus grand nombre de chercheurs et de directeurs.

- Les experts-conseils et les représentants d'autres organisations de la région devraient être invités à assister à la dernière session des <<utilisateurs>> proposée au paragraphe 6.3 ci-dessus.

6.5 Sujets d'ateliers éventuels

- Prélèvement et préservation des échantillons pour analyse de la qualité des eaux.

- Cueillette des données sur la qualité des eaux et techniques d'interprétation.

- Formation du personnel par rapport aux besoins d'acquisition des données dans le Nord.

- À partir d'une révision du présent atelier, identification des principaux intérêts et problèmes et organisation d'ateliers mettant spécifiquement l'accent sur ces questions.

PART II*

BACKGROUND PAPERS

PARTIE II**

DOCUMENTS DE BASE

*There are no background papers for Sessions 6, 14, 15 and 16.

**Il n'y a aucun document de base pour les sessions d'étude nos 6, 14, 15 et 16.

SYLLABUS

TECHNOLOGY TRANSFER - ENVIRONMENTAL IMPACT ASSESSMENT IN THE NORTH

OCT 31, NOV 1 and 2, 1978

	STARTING TIME	SESSION	TOPIC	SPEAKER AND AFFILIATION	SESSION CHAIRMAN
Oct 31	0830	1	INTRODUCTORY REMARKS	SLATER, DAVIS WSC IWD	NONE
	0900	2	AIPP SLIDE PRESENTATION	WAY, WSC	WEDEL
	1000	3	AIPP: GOALS, OBJECTIVES & PROGRAM DEVELOPMENT	SLATER, WSC	WEDEL
	1045	4	WATER RELATED ENVIRONMENTAL FACTORS	LANE, EMS	DAVIS
	1300	5	BASIN MORPHOLOGY	RANNIE U. OF WPG.	ALLAN
	1415	6	RIVER MORPHOLOGY AND ICE	NEWBURY, FMS	ZOLTAI
	1700	-	INFORMAL GET-TOGETHER AT WINNIPEG INN		
Nov 1	0830	7	MORPHOMETRIC & HYDROLOGIC DATA COLLECTION	WAY, WSC	HOFER
	1000	8	WATER CHEMISTRY	LANGTRY, DINA	McNEELY
	1100	9	BASIN STUDY - BATHURST ISLAND 1976	WEDEL, WSC	MACKAY
	1300	10	A DISCUSSION OF SNOWMELT	BARACOS U. OF WATERLOO	LYONS
			SNOW-MODELLING ON ELLESMERE ISLAND	AMBLER, WSC	
	1500	11	IWD DATA AND THE CONSULTANT	TEMPLETON TEMPLETON ENG.	
Nov 2	0830	12	THE EARP PROCESS	WOLF, FEARO	
	1000	13	CURRENT PROGRAMS AND NEW REQUIREMENTS FOR ENVIRONMENTAL IMPACT ASSESSMENT	SLATER WSC	
	1300	14	STAFF TRAINING NEEDS - AGENCY RESEARCH INTEGRATION	EISENHAUER PP AND PD	
	1430	15	WRAP-UP		
	1530	16	WORKSHOP EVALUATION	EISENHAUER PP AND PD	

Session I

INTRODUCTORY REMARKS

SESSION 1

ENVIRONMENTAL IMPACT ASSESSMENT IN THE NORTH

The purpose of an environmental impact account in the evaluation process is to analyse and record all identifiable effects which the plans under consideration may have on the environment.

There are five steps involved in evaluating environmental impacts. The approach consists of:

1. Inventorying existing conditions —
   - hydrologic, atmospheric, geologic, biotic conditions plus aesthetics and land and water uses.
2. Projecting conditions into the future.
3. Identifying areas likely to be affected by the plans.
4. Describing the expected effects of the plans.
5. Proposal of remedial measures.

The groups preparing assessments are attempting to provide the decision makers with the information on the impacts of the alternative plans they require in order to make a knowledgeable decision.

One of the purposes of this workshop is to examine the methodology that is used to acquire the information necessary to make informed environmental policy decisions.

Any group charged with the responsibility of performing an environmental assessment will be confronted immediately with at least five constraints. These include:

1. Finances
2. Manpower
3. Time
4. Politics
5. Technology

Unfortunately, these constraints are not independent. However, throughout this workshop we should try to concentrate our efforts to technology as this is the only factor over which hydrologists can exert some direct control.

The data that describes the available natural resources or explains the existing environmental conditions are very often, and for the north nearly always, the limiting factor in any decision related to the development or conservation of the resource.

The data network must consider the following variables for all the parameters being measured:

1. the number and location of sites at which data are to be collected;

2. the types of data that are to be collected at each site;

3. the period of time during which the data will be collected; and

4. the frequency of measurement of each data series.

No simple set of rules exists for adequately accomplishing an environmental assessment. The experiences of several hydrologic groups will be examined throughout the workshop.

In most instances in preparing environmental impact statements, satisfactory answers to the questions being asked cannot be given. Environmental assessment demands the best use of the tools currently available, recognizing their inadequacy while seeking to improve them.

The better the knowledge base, the better scientists will be able to serve the needs of society by providing more precise analyses of policy options.

Session 2

AIPP SLIDE-TALK SHOW

J.G. Way

Session 2 AIPP SLIDE-TALK SHOW 0900-0945

J.G. Way

This session is comprised of a series of 25 to 30 slides supplemented by descriptive commentary. The slides were judiciously selected from the hundreds of available photographs taken during the AIPP hydrologic regimes investigations in 1975 to 1977 inclusive. The slides serve to illustrate river forms and processes and terrain landforms and characteristics within the proposed pipeline corridor. In particular, slides of riverine instabilities and specific landform or geomorphic activity thought to have a bearing on pipeline design, construction and maintenance are included.

The slide presentation has been arranged in a geographic (i.e., south-to-north) rather than temporal order to illustrate the transition from the boreal forest of southern District of Keewatin to the sedge meadows of the wetlands on northern Melville Island. This visual presentation will serve as an introduction to subsequent sessions.

The slides being shown form a basis for the production of a 100-slide audio-visual package of IWD's involvement in the Arctic Islands Pipeline Program presently being prepared.

Session 3

ARCTIC ISLANDS PIPELINE PROJECT- HYDROLOGIC REGIMES

SESSION 3

ARCTIC ISLANDS PIPELINE PROJECT — HYDROLOGIC REGIMES

OBJECTIVES

Overall Objective: To accelerate engineering, scientific and technical investigations in the Arctic Islands so that the Government of Canada will be able to discharge effectively its responsibilities to ensure that a possible Arctic Islands gas pipeline would be built with due regard to the well-being of the northern people, to the protection of the natural environment, and to acceptable engineering standards.

Specific Objectives: To provide an overview of hydrology along the pipeline corridor north of Spence Bay, in order to provide data for an adequate assessment of the proponent's application.

Goals

1. To catalogue the hydrologic characteristics of the streams.
2. To provide baseline data for associated disciplines. (Fisheries and Water Quality)
3. To assess the geomorphology of the investigated reaches.

Questions

In what way will construction and operation of a pipeline affect the hydrologic environment as it relates to rivers and lakes?

What aspects of fluvio-morphology and hydrology will affect routing, design, construction and safe operation of a pipeline?

To answer these questions, data must be obtained prior to construction so that the effects of man's activities can be measured against a reasonable yardstick, and to permit qualified assessments to be made of the proponent's application. Requirements include data information on water quality, discharge, sediment transport, groundwater regimes, streambed percolation, icings, ice-runs and estimates of flood flows. Geomorphic information should describe the stream-associated land forms: valley walls, valley plain, floodplain, channel banks; and identify unstable conditions, such as, slides, slump, creep, solifluction, ground ice, thermal or dynamic riverbank erosion and channel instabilities — aggradation, degradation and migration.

Session 4

WATER-RELATED ENVIRONMENTAL FACTORS

Session 4 - WATER-RELATED ENVIRONMENTAL FACTORS

Previous speakers have described IWD participation in the AIPP program, an example of a costly, accelerated response by governments to a northern development challenge of considerable size. The example serves some historical purposes, providing a demonstration of the pros and cons of a type of baseline study which might well be considered as obsolete.

My purpose is not to provide a critique of either AIPP, or the process, but to describe the factors which IWD should consider addressing within the context of the current northern environmental assessment responsibilities of the Department. As you know, the realities of today are not consistent with the planning of AIPP-type programs, although the departmental position is still evolving.

Before addressing those factors, it would be fitting to set the policy framework which defines the type and degree of interest IWD should observe in environmental assessments in the North (i.e., the Yukon and Northwest Territories).

First, I should speak to the relationship between "baseline" and "environmental assessment". In its broadest context, baseline information can refer to data and interpretations of data which are collected to serve any of IWD's mandatory or discretionary responsibilities. However, the term is used most frequently in connection with departmental responsibilities for environmental assessment. What are those responsibilities?

If DFE is a project sponsor, the Environmental Assessment and Review Process requires that it follow the established procedures expected of an Initiator. This case is not considered further here, as it goes beyond the theme of the Seminar.

Where DFE is not an Initiator, its role is as follows: Initiators may seek advice from DFE in developing an Initial Environmental Evaluation (IEE) and in determining the signficance of environmental effects described therein. DFE will also provide persons to serve on Environmental Assessment Panels, where these are established to address cases of environmental significance. DFE may assist in the provision of guidelines for Environmental Impact Statements (EIS), and in the evaluation of EIS reports. Requests for advice are handled through Regional Screening and Coordinating Committees (RSCC).

In summary, referring to IWD, there is no responsibility to perform environmental assessment studies or collect data, unless:

- an Initiator requires assistance from IWD, and pays for it; or
- such data or study fundings are necessary to enable IWD to provide competent advice in setting guidelines for, or reviewing, EIS's, on aspects consistent with IWD responsibilities.

With this in mind, I wish now to examine those environmental factors of concern to IWD.

For convenience, I will first discuss water quantity aspects. IWD recognizes six criteria for identifying federal interest in hydrometric operations: interprovincial flows, international commitments, navigable waters, support to hydrologic research, basin studies, and national river inventory. With aspects solely related to environmental impacts in the North in mind, the list reduces to:

(i) interprovincial flows,

(ii) international commitments, and possibly

(iii) national river inventory.

The latter would refer to unlikely cases where developments could significantly affect water quantity trends.

International commitments are taken here to include not just those of IWD, but also those of other DFE agencies, where inland waters factors are relevant (e.g. migratory birds, weather and climate).

The federal interest in navigable waters belongs to another department which, of course, might contract IWD to perform baseline work. Basin studies, and hydrologic research programs, would not form bases for specific federal concerns beyond the interjurisdictional questions.

A water quantity concern not strictly related to hydrometric operations is that of flood damage, particularly where the flood plain needs to be define for cases involving federal funding or potential federal compensation. Examples of this are currently found North of 60^{o}.

Questions purely related to water quantity are normally dealt with by negotiated apportionment agreements with one exception described later. In the North, there are currently no expected developments which are likely to require Canada-U.S., or provincial-territorial apportionment agreements. The exception would be situations where water control developments threaten migratory bird habitat, or fisheries. In cases like that, IWD should be in a position to evaluate hydrologic models put forward by Initiators.

An analysis of water quality concerns of IWD clearly also produces items (i) and (ii), above, interprovincial and international commitments. A third interest stems from DFE responsibilities under the Environmental Contaminants Act, namely:

(iv) toxic substances.

There are expected northern developments which will definitely generate water quality concerns. Western and Northern, and Pacific and Yukon regions have recently identified specific development scenarios in the North, for a departmental submission to Senior Management Committee. I will not take the time to describe those details, but will present a set of problem types which are expected to be associated with those developments.

Sediment transport

Energy, mining and transportation developments in the North have the potential for causing disturbances to the naturally occurring sediment loads in moving waters. A desirable sediment load may be reduced, or the load may be increased, with adverse effects. To fulfill its responsibilities, IWD needs to know:

- the nature of problems induced by increased or decreased natural sediment loads,
- procedures for evaluating measurement techniques (e.g., en situ, remote), and
- procedures for evaluating predictive models of sediment transport and dispersal.

Toxic Substances

Concern about the presence of toxic materials in rivers and lakes in the North is shared with other federal and territorial agencies, where elements of the biota, including humans, may be endangered. Nevertheless, IWD bears clear responsibilities, relating particularly to the transport and behaviour of toxic materials in water systems.

Contaminants can be introduced to surface or groundwaters through excavation processes, waste disposal, or accident. Developments related to energy, mining, and transportation present each of those possibilities, and there are several examples of future projects to which these may well apply.

IWD will need to know:

- the types of problems engendered by the presence of toxic materials in surface and groundwaters
- procedures for evaluating measurement and analytical techniques
- procedures for evaluating predictive models pertaining to the behavior and transport of toxic substances in inland waters.

Other water quality concerns

Radioactivity - The occurrence and transport of radionuclides is a concern arising from uranium mining operations involving interjurisdictional flows. IWD requirements for these cases are identical with those for toxic substances.

Eutrophication - Although IWD is a leader in this field of study, northern developments are unlikely to require advice on eutrophication.

Oil - The occurrence of oil contamination in inland waters would most probably result from accidents. IWD responsibilities would require:

- the ability to evaluate models of oil behavior and transport in inland waters.

Heat - The disposal of low quality waste heat in lakes and rivers poses problems relating to migratory bird movements, fisheries, and local climate. This class of problems, however, is more likely to arise south of 60^{o}N and is not considered to be of priority in the North.

Baseline Data

IWD is uniquely placed to establish statistics of water quality and quantity information. Although initiating departments and proponents bear responsibility for collecting data and conducting studies necessary for environmental assessments, they cannot be expected to provide historic data necessary to establish baseline predevelopment conditions.

However, it is also unreasonable to expect that IWD should undertake to collect, for environmental assessment purposes alone, large quantities of data at many locations in the chance that they might be needed.

A proposed solution would be for IWD to plan and negotiate with provincial and territorial governments, a cost-shared program of baseline data collection, which would serve the purpose, taking into account that:

- existing networks provide considerable data,
- development scenarios are generally predictable, and
- representative data collections can often serve large areas.

It is estimated that a relatively small additional network would be required.

Session 5

ASPECTS OF DRAINAGE BASIN MORPHOMETRY OF RELEVANCE TO ARCTIC HYDROLOGY

Dr. W. Rannie

Session 5

ASPECTS OF DRAINAGE BASIN MORPHOMETRY OF RELEVANCE TO ARCTIC HYDROLOGY

Dr. W. Rannie

INTRODUCTION

The drainage basin acts as a filter between the precipitation inputs and water/sediment outputs of a river system. Thus within a given climatic regime, the magnitude and timing of outputs are essentially basin-controlled and an understanding of the nature of this control is fundamental to hydrology. Furthermore, the climate at the operational level of many hydrologic processes is not independent of basin morphology, an observation which is probably most true toward the extremes of climate. Because present knowledge of the manner in which water moves through the basin and in so doing acquires sediment is sufficiently imprecise that detailed modelling of the process is difficult even in intensively-studied temperate watersheds, let alone in the Arctic where data are sparse or non-existent, basin morphology has been used in a gross sense and particularly for comparative studies within or between regions. It is in this type of study, then, that its application to arctic watersheds is likely to lie in the near future. A complete review of basin morphologic properties is not possible within the space available here; useful reviews have been provided by Langbein (1947), Strahler (1964), Evans (1972), Mark (1975), Gregory and Walling (1973), Coulson and Gross (1967) and the references contained therein. This paper will focus on some basin properties which seem to be of particular relevance to arctic hydrology and will suggest some research directions which appear appropriate to an area about which comparatively little is known.

1. Basin Aspect

The aspect or orientation of the entire basin and of individual slope units within it is undoubtedly much more significant in the Arctic than elsewhere because of the importance of the spring freshet. A general southward or northward orientation of slopes within the basin may alter its "thermal latitude" by many degrees, thereby affecting the timing and magnitude of snowmelt runoff. Similar systematic variation in such hydrologically important factors as the depth of the active layer and the nature of vegetation between and within basins are broadly climatically controlled and thus related to aspect. Basin aspect may also exert a fundamental control on precipitation inputs. Basins with significant relief oriented normal to prevailing winds may induce orographic effects which increase precipitation above regional norms (or the reverse, depending upon the location of the barrier relative to the rest of the basin). More importantly, perhaps, is the effect of aspect on snow drifting; basins with a lee orientation may receive significantly more snow accumulation than those with a windward orientation. Similar effects may be

discernible at the scale of individual slopes or relief elements, particularly in the case of snow drifting where the confinement of snow at the end of the accumulation season to topographic depressions and lee slopes can be very striking. This clearly has implications for estimates of runoff volume from aerial or ground snow-cover surveys and affects the source-area distribution of runoff. In general, it is likely that the more concentrated the snow is in depressions, the more prolonged and less peaked will be the runoff.

Methods for determining basin aspect (orientation of the basin "lid") from point samplings of maps are described in Coulson and Gross (1967). On a smaller scale, measures might be developed to describe the gross surface roughness of a basin which, in combination with aerial survey and ground observation, could improve estimates of total snowpack runoff.

Methods are available for evaluating the effects of slopes of varying angle and orientation on incident solar radiation (Sellers, 1965; Garnier and Ohmura, 1968). Such techniques might be applied to representative basins to map the radiation climate in detail and compare actual net incoming radiation with measured values normally taken for horizontal surfaces.

2. Relief

Available relief provides the potential energy for all runoff processes and as such is a simple but fundamental descriptor of a bsin. In its most common usage, relief is synonymous with maximum relief or the maximum elevation difference within a drainage basin. This definition has however been questioned. Since it is based on extreme values, absolute relief is sensitive to small changes in boundary area and may be dominated by a small residual mass. Thus, some writers have preferred alternate measures such as percentil differences in relief distribution (Julian et al, 1967) or standard deviation of the relief distribution (Peguy 1948) as more stable indices. Evans (1967) and Drummond and Dennis (1968) have reviewed the problems of operational definition and statistical nature of relief measures.

Relief is at best a surrogate for potential energy gradients (slopes) across which runoff add erosion processes operate. Thus relief is commonly standardized by a representative horizontal basin dimension (commonly longest diameter or the square root of area) to convert absolute relief into a conceptual measure of overall gradient. While not especially meaningful in itself, such "relief ratios" are of obvious importance in "explaining" differences among basins in sediment yield (Schumm, 1954; Hadley and Schumm, 1961), water yield (Julian et al, 1967), sediment delivery ratio (Maner, 1958; Roehl, 1962), runoff ratio (Morisawa, 1959), time of concentration (Kirpich, 1940), etc. This widespread use of relief ratios as indicators of basin slope lies in their ease of measurement and the considerable problems of sampling slope angles over complex watersheds. Moreover, because slope varies

continuously in space, an average slope value has little meaning except in small conparatively homogeneous basins and provides no important advantage over artificial slope indices such as relief ratio. A relationship between relief ratio and actual hillslope angles has however been demonstrated by Schumm (1956), Morisawa (1959) and Melton (1958), among others. Relief, and indices dependent upon it, then, is a fundamental aspect of basin morphology which enters into virtually all attempts to explain gross regional differences in runoff and sediment yield.

3. Relief Distribution

The frequency distribution of altitudes or hypsometry is a fundamental property of drainage basins which has been used by geomorphologists to describe the "stage of evolution" of draianage basins (in a Davisian sense). While this is of minor importance to hydrologists, hypsometric analysis of drainage basins has numerous potential uses in the study of arctic basins. Strahler (1952) showed that the hypsometric integral (area under the hypsometric curve) is generally well-correlated with slope and channel gradients and drainage density, all of which have important hydrologic implications. The particular relevance of hypsometric analysis in arctic hydrology, however, would seem to lie in the climatic control exerted by elevation. Because air temperature varies with elevation, the advance of the melt season has both latitudinal and vertical components. The difference in timing of snowmelt between lowland and upland basins in the same radiation environment needs little elaboration. Provided there is a significant range in elevation, basins with a larger proportion of their area at higher elevation (high hypsometric integral) are likely to experience delayed runoff and perhaps lower peak flows than those which are predominantly at lower elevations (low hypsometric integral). Furthermore, since virtually all temperature data for the Arctic are taken at or near sea level, they cannot be transferred without modification to basins significantly above sea level. The progression of the melt season through the basin may be approached through the hypsometric curve and by combining the area at different elevations with a normal lapse rate, a type of degree-day weighting could be produced for all basins. The same conclusions apply in reverse to freeze-up. Thus, hypsometric analysis provides a potentially useful tool for comparing and explaining regional differences in the timing of runoff, peak flows and melt-season length.

Precipitation also varies with elevation and an accurate appreciation of total precipitation inputs frequently requires information on the proportion of the basin area which lies at different elevations. One interesting application in this respect involves the possibly significant role of condensation (or, more generally, accretion from the air in the form of hoar frost, rime ice and dew). In most climates, condensation plays a minor role in the total precipitation process but in areas of low precipitation, its relative importance increases. Ideal conditions for significant accumulation of condensation exist in arctic coastal locations where cold rock surfaces provide large receptors for condensation from moist onshore air flows. If the sparse data from Norway are any

gauge, condensation may be a very important (but almost totally overlooked) input of water to arctic hydrologic systems. Landsberg (1968) cited values of rime deposition in Norway ranging from 35 mm at 860 metres above sea level to 1310 mm at 1140 metres above sea level, the latter value exceeding normally measured precipitation by 100 mm! He also noted the very sharp increase (from 70 mm to 590 mm) which occurred within an 85-metre elevation difference about the normal cloud base. Hypsometric analysis of coastal basins, in combination with humidity, temperature, wind speed and saturation level of the onshore air flow might provide an avenue of approach to this problem.

4. Drainage Density

Drainage density, defined as the total length of channels within a watershed divided by watershed area, has come to be regarded by geomorphologists as one of the most sensitive and dynamic of all basin properties.

> Perhaps the most informative single parameter of a basin is one which describes its texture, for example, drainage density . . . The channel network and its texture . . . provide the crucial link connecting hillslope and river studies . . . Hillslopes should be studied essentially as a sediment transport system . . . in which the rivers are only a means of moving debris; whereas rivers should be studied as a water transport system . . . in which the slopes are only a topography which modifies the water flowing into its channels . . . the dynamic equilibrium which maintains the density of the channel network provides the essential link between these two systems and these two viewpoints. (Carson and Kirkby, 1972, p. 424)

The significance of drainage density in the runoff-erosion process is indicated by the fact that it has been shown to be inversely related to average length of overland flow (Horton, 1932), basin permeability (Kuska and Lamarra, 1973), baseflow proportion (Carlston, 1963; Orsborn, 1970) and directly related to overland flow (Melton, 1958), mean annual flood (Carlston, 1963), and mean annual unit sediment yield (Hadley and Schumm, 1961; Lustig, 1965; Scott et al, 1968). Drainage density has also been shown to exert a fundamental control on mean valleyside slope, since it is through the dissection of a landscape by a stream network that absolute relief is transformed into slopes of given average length and steepness. Thus, Langbein (1947) found a positive correlation between drainage density and mean slope in New England basins. Strahler (1958) adapted Horton's geometric analysis of the relationship between drainage density and slope length to show that average local ground slope should he proportioned to HD where H is local relief. He then extended this concept to an entire drainage system by defining the Ruggedness Number, HD, in which H becomes any representative relief property (normally absolute relief). A clear relationship was found between the Ruggedness Number and mean valleyside slope for small basins in six widely-separated regions of the United States. In a number of small semi-arid watersheds,

Melton (1958) found that the same elements were related to maximum valley-side slope by an empirical regression equation of the form:

$$\theta_{max} = a. \frac{L^{0.25} H^{0.5}}{(\sqrt{A})^{0.75}}$$

where θ_{max} = maximum valleyside slope; H = basin relief; A = basin area; and L = total channel length. The term on the right of the equation is clearly seen to decompose into the product of relief ratio ($H/\sqrt{A}$) and a dimensionless drainage density ($L/\sqrt{A}$) taken to the 0.5 and 0.25 powers respectively. It is thus analogous to the Ruggedness Number, and supports Strahler's conclusion that average valleyside slope angles in small basins are adequately summarized by measures of relief and drainage density.

Drainage density, then, is the most dynamic and adjustable of all morphometric properties and undoubtedly contains the most informaton concerning the nature of runoff and erosion processes within a watershed. Its use in morphometric analysis, however, is confounded by the fact that it is nearly impossible to measure with consistency and accuracy in even moderate-sized basins. The simplest method, adopted by Horton (1932, 1945) and many subsequent writers is to measure the total length of all permanent and intermittent streams which are indicated as blue lines on large-scale topographic maps. Other methods which have been proposed include field and airphoto mapping of permanent channels and the "contour crenulation method". In the latter, the blue-line network is augmented by adding streams wherever the bending of contours indicates a valley in which no stream is shown on the map. The advantages, disadvantages and comparability of such alternative methods have been discussed by Morisawa (1957), Schneider (1961), Gregory and Walling (1972) and Drummond (1974). In general, the application of these methods is not practical for basins of more than a few square miles, as a review of the studies in which they have been used will readily demonstrate. Measurement problems are possibly less restrictive in arctic basins, however, where the absence of large-scale maps is more than compensated for by the better view of the stream system which can be obtained from airphotos. It is likely that sufficient detail is obtainable in small sample areas to enable extrapolation over much larger basins. If this methodology is combined with extensions of Horton's Laws (eg, Strahler, 1964), accurate and consistent drainage density data are probably possible. While the interpretation of variations in density within the Arctic will undoubtedly differ from those in other regions, there is no reason to believe that its status as the most interesting basin property will be affected.

5. Drainage Area

Although drainage area would appear to be one of the more straightforward characteristics of a drainage basin, this is not always the case. Anderson (1957), in discussing variation in sediment yield, described area as the "devil's own variable". The difficulties of interpreting the role of this basic scale measure lies in the fact that it correlated with a great many other morphometric and hydrologic watershed characteristics, Strahler (1964) and Gregory and Walling (1973) discussed a number of the correlations which exist between area and such basin properties as stream length, absolute and relative relief, basin perimeter, average slope and drainage density. Gray and Wigham (1970) and Gregory and Walling (1973) have summarized the control that basin area exercises over the hydrologic performance of a stream system, particularly its effect on mean annual flood, mean annual runoff, maximum flood and peak 24-hour flow. Other characteristics such as lag time, time of concentration and hydrograph shape have more frequently been related to watershed length parameters which are themselves dependent upon area (Gray, 1965). Many writers have demonstrated the normal decrease in unit sediment yield with increasing basin area (Anderson, 1957); Collins, 1970; Piest, 1972). This is partially attributable to greater spatial variability of runoff-producing storms as basin area increases and partially to the negative correlation between sediment delivery ratio and area (Roehl, 1962; Vanoni, 1975).

The role of drainage area is confused in some regions by differences between gross drainage area and "effective area" or that area which actually contributes to total and/or peak stream flow. This is particularly true of some prairie basins where large total areas of unconnected sloughs may reduce the gross area enormously. In the case of arctic basins, the hydrologic equivalent is the "thaw lake" which, if present in sufficient numbers, might significantly alter the definition of drainage area (and any calculations based on it). In addition, particularly in recently deglaciated terrain, closed depressions are often numerous due to insufficient time for drainage re-adjustment. These should be carefully examined on the ground or from airphotos to determine whether they in fact are likely to contribute to the hydrologic variable of interest.

6. Area of Lakes

Lakes and bogs within a drainage system store water at peak periods and release it at a later date, with the effect that daily and seasonal rhythms which characterize snowmelt runoff are dampened and runoff characteristics are in general more poorly correlated with their hydrometeorological causes. Thus, streams with significant lake area in their basins display lower and more prolonged peaks and frequently a more prolonged runoff season than might be predicted. The effect of lakes on the throughput of sediment needs no elaboration. Because lakes and bogs are not uncommon in much of the Arctic, drainage systems in these areas require special attention and probably should be treated as a separate

population in any comparative analysis. As a general comment, whenever there is a choice in the location of a gauge, it would preferably be located upstream of a lake rather than downstream (which is frequently more convenient). The records thus obtained are likely to be more meaningful reflections of regional morphohydrologic characteristics.

7. Glacierized Area and History of Glaciation

The presence of glaciers or permanent snowpatches within a basin has obvious hydrologic consequences for the amount and fluctuations in discharge, the relationship between runoff and climate, and sediment transport. Excellent reviews of the nature of proglacial hydrology and sedimentation are provided in Anonymous (1967), Church (1972, 1974) and the references therein. Of particular interest in many arctic situations is the notion of paraglaciation, first introduced by Ryder and Church (1972). The term paraglacial refers to nonglacial processes which are directly conditioned by glaciation, either at present or in the recent past. Under paraglacial conditions, Ryder and Church demonstrated that rates of sediment production are much above normal due to the abundant supply of materials, poorly-adjusted drainage network and generally poor vegetation cover. With time, sediment transport and deposition decline from this maximum toward the geological and climatic "norm", marking the end of the paraglacial period. Consequently, basins in different stages of this progression are likely to display different sediment transport rates, even when all other factors are identical, and it might be wiser to consider time-since-glaciation as a variable in any study of regional variations in sediment transport.

8. General Comments

(i) The use of morphology in prediction equations

Aspects of morphology have long been used in empirical multiple-regression equations for predicting such hydrologic elements as mean annual runoff floods of varying frequency, sediment yield etc. and there is no need to review them here (for a recent example, see Patton and Baker, 1976). This use is most important on a regional or multi-regional scale when data from gauged areas must be extrapolated to ungauged areas. At the other extreme, regression equations are frequently developed for individual basins, relating, for example, snowmelt runoff and degree-days, sediment discharge and mean daily water discharge, effective precipitation and peak flow, etc. This practice is also necessary for extrapolating from the known (in this case sampled or short time-period data) to the unknown (usually the continuous record). There have been relatively few attempts, however, to combine the two approaches--that is, to develop regional or broad equations which will predict regression lines for individual watersheds from morphometric and other data. This approach can be illustrated using a method of obtaining reconnaissance estimates of sediment rating curves developed by the writer (Rannie, 1978).

Sediment rating curves relating mean daily discharge and sediment transport are routinely used to permit estimation of total sediment yield from periodic measurements of sediment concentration. Such sediment rating curves are normally expressed as simple power functions of the form $G_s = kQ^j$, where G_s = sediment transport rate, Q = mean daily water discharge and k, j are constants for a given basin. In view of their widespread use, sediment rating curves have received little attention themselves and few attempts have been made to generalize their properties. Using a sample of 50 small basins in the United States and southern Ontario, the writer found that k and j can be predicted from simple morphoclimatic variables and that a general sediment rating function could be described by the following equation:

$$G_s = c\ Z\ Q^{1.581 - 0.155 \log c - 0.155 \log Z}$$

$$c = 118.0; \quad Z = q^{-2.304}\ H^{-1.209}\ A^{-0.676}$$

where G_s = suspended sediment transport rate (tons per day); Q = mean daily discharge (cfs); q = mean annual unit discharge (cfs/mi.^{2}; H = basin relief (feet); A = basin area (square miles). Other equations based on mean relief and standard deviation of relief were also developed. No significant improvement was obtained by the inclusion of drainage density, channel slope or basin hypsometry. The probable errors which result from the application of this general function are substantial but not more than would be expected from other means of estimating sediment transport in unsampled streams. Furthermore, because of the internal structure of rating function, the relative error is likely to decrease as discharge increases, a useful property since the greatest amount of sediment is transported by high flows. For example, in the 50 study basins, the probable error in estimate of sediment transport reduced from 285% at 1 cfs to 143% at peak discharge and it is likely that the long-term error is even smaller.

The application of this equation to arctic basins is questionable since it is based on sample basins in very different environments. The study is introduced however, to illustrate a methodology which might be applied in arctic areas to generalize sparse data. Many other relationships can be described by simple linear equations or can be linearized by a suitable transformation, and if attention is focused on the correlation of the slopes and intercepts of these equations with basin morphometric and other characteristics, general relationships might be developed which provide reconnaissance estimates of broad validity. Another potential use of such general functions is to provide standards against which data from an individual basin may be assessed. In the case of the sediment rating curve (and many other such empirical devices) there exist no such standards at present and consequently there is no way of evaluating whether a given sediment rating curve is unusual for its morphoclimatic environment and thus worthy of further study.

(ii) Analogy between arctic and other hydrologic systems

Among the characteristics which distinguish many arctic hydrologic systems are the following: scanty or non-existent vegetation cover, low infiltration rate, impermeable surface or near-surface substrate, strongly seasonal runoff regime, very high direct and (hence) very low baseflow runoff components, a high overall runoff ratio, and a tendency toward "flashiness" of runoff. Many or all of these characteristics are shared with both urban and warm semi-arid basins, in the latter case particularly those underlain by shales. In basins with these characteristics, the relationships among climate, morphometry channel development and water/sediment discharge are likely to be simple and more direct than in forested temperate areas (which probably explains why much of the early research in describing the relationships among morphometry, runoff and erosion was conducted in semi-arid regions). Similar success might be anticipated in the development of morphometric-based empirical equations for arctic areas and it appears probable that some runoff models which have been developed for semi-arid or urban situations might, with suitable modification, be applied to arctic basins. A review of these models might be a useful beginning to any data collection program.

Important use might also be made of the large body of erosion plot data. Because these plots are normally bare or lightly-vegetated, their use in non-agricultural situations has been restricted. In the Arctic where such conditions are common, however, relationships among velocity of overland flow, erosion, slope length, slope angle, the beginning of rill development, etc. may be more applicable.

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Session 7

MORPHOMETRIC & HYDRAULIC DATA COLLECTION PROGRAMS

J.G. Way

Session 7

MORPHOMETRIC & HYDRAULIC DATA COLLECTION PROGRAMS

J.G. WAY

The prime purpose of the session is to demonstrate how office and field data collection techniques utilized in the AIPP program may be applied to maximize hydrologic and hydraulic data recovery for other projects requiring inputs for an environmental impact assessment.

1. Office Techniques

a) Selection Criteria:

- representation of river system based on zonal criteria, i.e., physiographic features, vegetal cover, basin aspect, geologic formations, etc.
- river form and process, i.e., split-channel, braided pattern, entrenched channel, regular or irregular channel, bedrock channel, alluvial river, etc.
- airphoto analysis of specific sites selected.

b) Standard Map Sheet and Analyses:

- much data of hydrologic and geomorphic significance may be obtained from standard topographic map sheets.
- based on the experiences of geographers Strahler and Horton, the significance of parameters obtainable from map sheets can be explained.
- parameters obtainable from map sheets include drainage area basin perimeter, circularity ratio, stream order, bifurcation ratio, length of principal channel, slope of principal channel, basin width, basin length, elongation ratio, hypsometric integral, hypsometric coefficient, basin relief, basin aspect, etc.

c) Grid-by-Number Bed Material Photo Analysis:

- explanation of techniques used in the office to obtain a particle size distribution of bed material. From the particle size distribution curve, D_{35}, D_{50}, D_{65}, are easily obtainable for use in hydraulic formulae.

d) Hydraulic Computation Procedures:

- use of Manning's equation, Strichler's "n", Einstein-Barbarossa equation, log-log extensions to derive high-water discharges. Empirical relationships.

2. Field Techniques

a) Field Hydraulic Data Collection:

- in addition to standard hydrometric data, data collected on cross-sections, riverbed profile, longitudinal water surface, profiles and high-water marks were utilized in deriving peak flow values.

b) Geomorphic Assessment Forms:

- a standard reporting form patterned after previous work by Church, Kellerhals and Bray was developed to enable compilation of a generalized description of geomorphic features.
- form development, content and revisions will be discussed.

c) Special Sediment Sampling Techniques:

- modifications to standard sediment survey equipment.
- transfer of laboratory technology to new field collection techniques for sediment.

d) Other Field Data Collection: Procedures:

- standard section photo set.
- "permafrost table" profiling.
- field tests for pH, temperature and conductivity.
- riverbed, bank and substrate material analysis.

3. Incorporation of AIPP Field Techniques into Standard IWD Hydrometric Procedures

- pros and cons of implementation.
- training requirements for IWD staff in order for implementation to proceed.
- general discussion.

J.G. Way

Session 8

A BIOLOGIST'S VIEW ON THE ROLE OF WATER CHEMISTRY IN ENVIRONMENTAL ASSESSMENT

E.K. Langtry

SESSION 8

A BIOLOGIST'S VIEW ON THE ROLE OF WATER CHEMISTRY IN ENVIRONMENTAL ASSESSMENT

E.K. Langtry

Introduction

A few years ago much of the water quality information available to the environmental scientist was limited to chemical data. Many biologists considered this an intolerable situation since they were convinced that aquatic flora and fauna are at least as good, if not better, indicators of water quality than are chemical parameters. Unfortunately the pendulum may now have swung too far in favour of biology.

The Value of Water Chemistry

The quality of the aquatic environment is a function of its physical, chemical and biological characteristics. Since these various components interact dynamically it is not reasonable to evaluate water quality without some understanding of all its facets. Figure 1 is a primary interaction matrix that illustrates how a number of aquatic properties influence each other. There is considerable interdependance of parameters within each of the physical, chemical and biological divisions, as well as interactions between these major categories. The biota is particularly dependent on the chemistry of its habitat.

Figure 1. Primary Interaction Matrix for Water Quality Parameters

DEPENDENT PARAMETERS		DETERMINING PARAMETERS: PHYSICAL — Light Penetration	Precipitation	Air Temperature	Hydrology	Morphometry	Geology	CHEMICAL — Major Ions	Nutrients	Trace Metals	Dissolved Gases	Water Temperature	Particulate Matter	pH	BIOLOGICAL — Microbes	Macrophytes	Phytoplankton	Zooplankton	Benthos	Fish
PHYSICAL	Light Penetration		*		*	*							*	*	*	*	*			
	Precipitation			*		*														
	Air Temperature		*									*								
	Hydrology		*			*						*								
	Morphometry																			
	Geology																			
CHEMICAL	Major Ions		*		*		*					*		*	*	*	*			
	Nutrients		*		*									*	*	*	*			
	Trace Metals		*		*		*							*	*	*	*			
	Dissolved Gases			*								*		*	*	*	*	*	*	*
	Water Temperature		*	*	*											*				
	Particulate Matter				*		*								*		*			
	pH		*		*		*	*			*	*								
BIOLOGICAL	Microbes				*	*		*	*	*	*	*	*	*		*	*	*	*	*
	Macrophytes	*			*	*		*	*	*	*	*	*	*						
	Phytoplankton	*			*	*		*	*	*	*	*	*	*				*	*	*
	Zooplankton				*	*		*	*	*	*	*	*	*	*	*	*	*		
	Benthos				*	*		*	*	*	*	*	*	*	*	*	*	*		*
	Fish				*	*		*	*	*	*	*	*	*		*	*	*		

Due to their general responsiveness to changes in physical and chemical conditions, biological indicators have become standard measures of water quality. While these indices are valuable tools, their use with the exclusion of other disciplines is not recommended. Biology is not as precise a science as chemistry, and the natural variability in biological data may either mask or falsely indicate significant changes in the environment. However, if reliable chemical data are also available then it may be possible to confirm or reject apparent trends in the biology. In addition, the reaction time between changes in water quality and a measurable biological response may be substantial. However, changes in water chemistry are usually more immediate and can indicate deleterious changes before problems become irreparable.

Deficiencies in I.W.D. Programs

The function of an environmental impact statement is to provide both an inventory of existing environmental conditions and to predict changes due to man's developments. Unfortunately, a failure to integrate the studies of the various environmental disciplines is characteristic of most EIS's.

The chemists, biologists, hydrologists and engineers usually conduct and report their own studies then conclude with a series of spurious motherhood states which could have been documented prior to the collection of any new data. Regrettably, traditional IWD programs have done little to eleviate this problem. Instead, the mass of chemical data collected annually often fails to accurately characterize the aquatic system it supposedly represents, and it usually is not integrated with the studies of other disciplines.

Providing Reliable Chemical Data

Table 1 outlines the main sources of variation in chemical data. Both sampling error and analytical deficiencies represent human failings rather than environmental variability. Therefore, considerable effort should be given to eliminating these two sources, particularly the former which probably accounts for much of the unwanted variability in chemical data.

Table 2 lists 20 common chemical parameters along with some of their handling and analytical requirements. Many of these analyses are best completed in the field because reliable field methodologies are available, and/or because sample

Table 1. Sources of Variation in Water Chemistry

Source of Variation	Control of Variation
Sampling Error	- careful sample collection and handling by trained chemical technicians
Analytical Deficiencies	- prevent sample degradation by proper preservation and short turn-around time between sample collection and analysis - standardization of analytical techniques
Intra-Station Variance	- replicate samples at each station to obtain an estimate of this variability
Inter-Station Variance	- select sampling stations at a variety of locations that characterize the study area
Temporal Changes	- sample on a regular basis through the year and also from year to year

Table 2. Sampling and Analytical Requirements

Parameter	Container	Comment	Field Operations	Lab. Analysis
A. Physical				
alkalinity	P or G	- analyze immediately or microbiol activity may alter results	titration	---
colour	G	- complete in field using standardized colour comparitor	comparitor	---
conductivity	P or G	- measure immediately to avoid changes in ionic species	meter	---
dissolved oxygen	G	- measure immediately to avoid temp. & microbiol effects	titration or meter	---
light penetration	-	- measure in field comparing incident radiation at surface with depth	meter	---
taste	G	- taste immediately in field for subjective evaluation	observation	---
temperature	-	- measure immediately in field	thermometer or meter	---
turbidity	P or G	- measure in field in NTU's (nephelometer)	meter	---
B. Trace Metals				
arsenic	P or G	- "extractable" (total) concentrations can be analyzed from samples acidified (2 ml HNO_3/l) in the field - "filtrable" (dissolved) concentrations require immediate filtration through 0.45µ membranes before acidification - analysis by atomic absorption	field preparation required	atomic absorption
cadmium	P or G			
copper	P or G			
lead	P or G			
mercury	P or G			
zinc	P or G			
C. Nutrients				
nitrate-nitrite	P or G	- "total" value can be determined on whole sample, but "filtrable" (dissolved) will require filtration through 0.45µ membrane - to minimize microbiol alterations keep samples on ice & complete analysis within 24 hr.	icing	spectro-pnotometer
total phosphorus	P or G	- "total" value can be determined on whole sample, but "filtrable" (dissolved) will require filtration through 0.45µ membrane - no sample preservation required	---	spetro-photometer
D. Organics				
grease & oil	G*	- acidify sample with HCl in field to pH <2	acidify	spectro-photometer
chlorinated phenoxy acids	G**	- no field preservation required	---	gas chromoto-graphy
organophosphates & carbamates	G**			

G - glass
P - polyethylene

* solvent rinsed wide-mouth jar
**solvent rinsed

deterioration during transport to a laboratory would provide meaningless results. Although the remaining determinations require the more sophisticated setting of a laboratory, careful sample collection and preservation is still necessary in the field.

To reduce human error, field technicians must be fully qualified people with a thorough understanding of water chemistry, and of the problems resulting from unsatisfactory sample handling practices. Therefore, it is generally unreasonable to expect the local postmistress or RCMP officer to collect satisfactory water samples.

Since the remaining three sources of variation in Table 1 reflect the natural environment, then water quality studies must be designed to estimate each of the three. Intra-station variability is due to the natural heterogeneity in the distribution of chemical parameters at a single location. Sample replication is therefore required at each station to provide a measure of this variability.

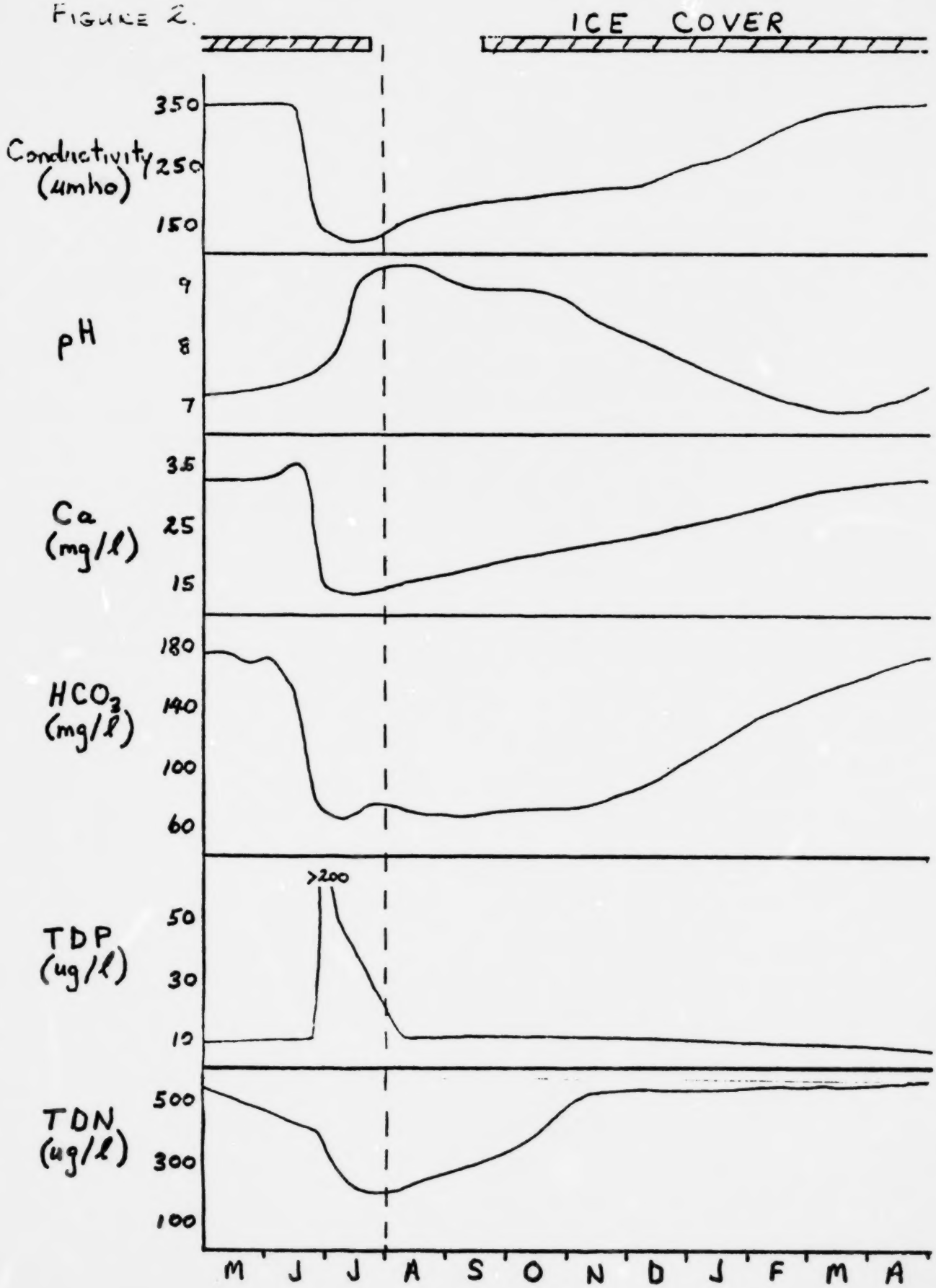
Inter-station or spacial variance is due to differences in water chemistry from one part of a study area to another. Estimation of these differences require that sampling stations be widely distributed throughout a single study area. Furthermore, a sufficient number of stations is necessary to adequately sample the area and all its diverse features.

Finally, temporal changes in water chemistry can be investigated only if sampling occurs on a regular basis throughout the year, and also from year to year. Since one cannot expect a hydrologist to speculate on mean discharges based on a single flow measurement, similarly a chemist should not be asked to describe water chemistry with data from infrequent sampling.

Figure 2 summarizes some water chemistry data collected from a 3 m. depth in Meretta Lake (Cornwallis Island) in 1971-72. Clearly a single grab sample taken during a convenient open-water period would not have been representative of average conditions. Similarly, a recent study by the Water Quality Branch in Vancouver (Oguss and Erlebach, 1976) demonstrated the problems with infrequent sampling. It was found, for example, that during this study on the Thompson River, that should a single sample have a total phosphorus concentration of 0.054 mg/l, then the true quarterly mean value was between 0.0 and 0.127 mg/l (based on 95% confidence limits). With such low levels of precision it would be unwise to speculate on any trends in chemical data.

Oguss, E. and W.E. Erlebach, 1976. Limitations of single water samples in representing mean water quality. I. The Thompson River at Shaw Spring, British Columbia. Environment Canada, Inland Waters Directorate Tech. Bull. No. 95.

FIGURE 2.


ICE COVER
Conductivity (μmho)
350
250
150
pH
9
8
7
Ca (mg/l)
35
25
15
HCO_3 (mg/l)
180
140
100
60
TDP (ug/l)
>200
50
30
10
TDN (ug/l)
500
300
100
M
J
J
A
S
O
N
D
J
F
M
A

Integrated Environmental Studies

Although careful water analyses and frequent sampling will provide accurate chemical data, it will be difficult to interpret the environmental significance of the information unless chemical studies are integrated with other disciplines. There is much more to integrated investigations than having an engineering technician, who happens to be changing a chart at a hydrometric station, collect a grab sample in a Mason jar. As already mentioned, the technician must be skilled in chemical procedures.

A thoroughly integrated study program can be achieved when experts in the various environmental disciplines discuss, in a workshop setting, the data they need from each other and how this information can be gathered in the most expedient fashion. As part of this interdisciplinary cooperation, both sampling effort and station locations should compliment everyone's objectives. For example, when selecting water sampling stations, consideration must be given to the location of:

a) major physical features in the drainage basin;

b) hydrological stations;

c) important habitat;

d) different habitat types.

Where major developments are proposed the integration of effort should also occur between the proponent's environmental consultants and the various government agencies. Too often the consultants have inspected every river and lake in a study area, and government personnel have duplicated the effort both to familiarize themselves with the region and to allow evaluation of the consultant's work. It may be more productive if the general environmental inventories become the sole responsibility of the consultants, and government scientists directed their efforts toward intensive investigations on a few representative water systems. These selective but thorough programs would not only acquaint government people with a particular study area, but would also allow them to investigate ecological functions. With a comprehensive understanding of how a system works then one is better able to predict what changes will occur if the environment is disrupted. Once a few systems have been completely modelled, the predictive proficiency acquired from them can be applied to the dynamics of other similar systems. Environmental assessment skills will be greatly enhanced through a combination of the diagnostic abilities developed as a result of modelling, and the symptoms provided by resource inventories.

Conclusions

1. Water chemistry is important for environmental assessment purposes, but traditional studies have often failed to assist in impact predictions.
2. The variability in chemical data can be controlled and identified with suitable study schemes. Proper sample handling and analyses by trained chemical technicians will eliminate variance due to human error. The variability characteristic of natural waters can be accurately estimated by careful selection of sampling frequencies.
3. Chemical studies will achieve their maximum value when they are integrated with research in other environmental disciplines.
4. A thorough understanding of ecological processes can be gained through intensive research on selected aquatic systems. The predictive capability that will be generated from modelling exercises will improve the quality of environmental impact evaluations.

Session 9

BASIN STUDY - BATHURST ISLAND - 1976

(Arctic Islands Pipeline Project)

J.H. Wedel

Session 9

BASIN STUDY - BATHURST ISLAND - 1976
(Arctic Islands Pipeline Project)

J.H. Wedel

A. CONTEXT

Geographic

O.H. Figure 1 - sensitive regions identified in 1975 reconnaissance:

1. East Melville and West Bathurst
2. Southern Boothia

Two basins were proposed for study, one in each region. Essentially sensitivity criteria established because of uncohesive soils and attendant high erosion-siltation rates.

Chronologic

Intensive study designed to complement the qualitative overview obtained in previous year with an array of quantitative data.

B. SELECTION CRITERIA

1. Should be located in region of suspected high sediment yield.
2. Should not duplicate any ongoing hydrologic studies—i.e., should collect data in an area with little or no hydrologic information.
3. Basin should be small enough to permit investigators access to all portions by overland vehicles (skidoo and ATV vehicles such as Honda 90 tricycles).
4. Basin should be within reasonable distance from Resolute Bay.

Snowbird Creek was deemed to meet these criteria.

C. LOGISTICS

1. Budget

Original submission 85K all up including salaries, OM and capital - cut back to 67K. Final cost 82K.

LOGISTICS (continued)

2. Staff

AIPP team alternated 3 teams:

May-June	-	3 men
July	-	2 men
August	-	2 men

3. Accommodation

In transit at PCSP, Resolute
Camp - Hurritent, kitchen, warehouse,
Parcoll 12 x 20 living quarters
bought in late June.

4. Transportation

a) Commercial airline to R.B.

b) PCSP Charter (twin and single Otter on tundra wheels)

c) Operations: Skidoo Olympique Honda ATC 90 trikes plus trailer.

D. PARAMETERS INVESTIGATED

1. Insolation

Measured at camp by Moll-Gorcynski type solarimeter interfaced with ICA Model 400 analog recorder - output in Langleys. Albedo measured with similar instrument but didn't function.

2. Temperature

Measured twice daily by Hg bulb thermometers, max & min thermometers in Stevenson screen at camp; max-min also recorded at remote raingauge sites.

3. Wind

Accumulating anemometers 1 and 5 metres above ground at camp. Read twice daily.

4. Relative Humidity

Wet bulb thermometer in Stevenson screen.

5. Snow Survey

Mr. Rose Sampler - 561 depth samples on basin transect, 52 density samples (every 10th depth sample). Survey made June 10. Partial survey on June 17.

6. Snowmelt

From aerial photography, systematic photography of snowbed recession, satellite imagery by calculation.

7. Sublimation

Polystyrene-lined lysimeters - experiment unsuccessful.

8. Condensation - calculated

9. Precipitation

Raingauge network, two recording raingauges (Chapman-Davis type).

10. Runoff

Measured by wading. Price pattern 622 current meters. Stage recorded at two sites by Hg manometer - OTT XX gauges.

11. Slushflow - photographic documentation.

12. Mass Movement

Staked apparently active sites with wire flags - periodic measurement.

13. Sediment Transport

Suspended samples - D48 sampler.
Bedload - Helley-Smith) samples
Bogardi)
Dissolved sediment - measured as residual in lab analysis.

14. Channel and Bank Forms

- by conventional survey;
- by comparison of aerial photography.

E. RESULTS

1. Found that runoff values obtained agreed well with snow survey data in a water budget equation.

2. Found that recalculation of AES snow depth recalculation based on end-of-May depth x derived density produced reasonable data. Runoff >indicated in Hydrologic Atlas.

3. Sediment load >indicated in hydrologic atlas.

Session 10A

A DISCUSSION ON SNOWMELT

P.C. Baracos

A DISCUSSION ON SNOWMELT

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OCTOBER 1978

I Introduction: The Importance of Snowmelt

Throughout Canada the melting of snow usually contributes a significant portion of the yearly runoff. In the North especially in the Arctic, most of the runoff comes from snowmelt. Estimation of future runoff is necessary for the planning and operation of water projects such as hydro-electric complexes, water supply installations, and flood control works. The ability to predict how much runoff there will be and when it will arrive is very important. This information can to a large extent be derived from a knowledge of the quantity of snow on the ground and from an understanding of the processes invoved in its melting.

Equally important is the field of environmental impact assessment. It should be possible to use historical weather records and snowmelt models in the simulation of complex natural systems in order to predict the effect of some proposed man-made intervention. Examples of such an intervention are; the building of a dam or a pipeline, or the instituting of a program of pollution management. In the case of interventions that have already occurred the effects can be quantitatively measured using recently developed models. It should also be possible to use snowmelt and runoff models in order to recreate missing hydrometric record and to extend existing record for stations where the existing length of flow record is short but where longterm weather records are available. This extended record is needed because environmental changes cannot be assessed if it is not known what the conditions were before the change.

Within this paper two general areas are dealt with. The first is the problem of collecting adequate data concerning the quantity of snow available for melting, and methods of improving the quality of data available. The second area covers mathematical modelling of snowmelt, including new techniques for fitting models and choosing among the variety of different models that are currently in use.

II The Problem of Measuring Snow Quantity

Most of the snow data currently available is collected by the Atmospheric Environment Service, (A.E.S.). There are a number of problems involved in using A.E.S. data for hydrologic purposes. The first of these is the problem of "undercatch" of snow in precipitation gauges. On windy days falling snow tends to blow past a precipitation gauge rather than fall into it. There does not appear to be any simple solution to this problem, but even if there were, there would still be the related problem of drifting snow. In the North where ground cover is sparse there is no way of knowing whether the snow will stay in the basin in which it falls or whether it will in fact be blown into a neighbouring catchment. Both of the above problems can be neatly sidestepped by conducting snow surveys just prior to the start of the melt period instead of trying to measure the snow as it falls. A snow survey consists of the measurement of the depth and density of the snow at a series of sample points known as a snow course. It is necessary to insure that the snow course is chosen to be representative of the entire basin or study area in question. The configuration of the snow course and the number of sample points needed depend strongly on the physiographic characteristics of the basin in question, and should be selected on a regional or even on an individual basis, depending on local conditions.

Some snow courses are currently being run by the Atmospheric Environment Service. However because A.E.S. is primarily interested in aviation reports and weather forecasting, little effort has been made to set up snow courses to be representative of a basin for hydrologic purposes. In fact the snow courses tend to be found beside airport runways, which are probably not very representative locations. To further aggravate the situation, A.E.S. procedure has been to arbitrarily use a snow density of 0.1 gm/cc in calculation of water equivalents for publication. In the Arctic where snow densities of 0.3-0.35 gm/cc are commonly found, this can lead to a sizeable error in the estimation of the quantity of snow on the ground. Consequently it is suggested that the Inland Waters Directorate conduct its own program of snow courses to provide data specifically applicable to the needs of hydrologic studies.

III Modelling of Snowmelt

Mathematical models of snowmelt can be used in applications such as the reconstruction of missing hydrometric record, in water system simulations, and in prediction of future melt rates for use in flood forecasting and hydro-electric or water supply planning. Snowmelt models may be either explicit or implicit. In the first case, an explicit model will have the output directly in terms of depth of melt. The output of the snowmelt model can than be fed as an input to some other model, say a watershed model. Often meltwater inputs to watershed models are then treated in much the same way as precipitation inputs. An implicit model is one whose output is some parameter , such as streamflow, that is highly dependent on snowmelt, and where the principles of snowmelt are used as an implied step in the model.

Traditional Modelling Techniques

Because the energy required to melt frozen water (79.63 cal/gm) is well known, one should in theory be able to calculate snowmelt rates from the sum of all forms of heat entering or leaving the snowpack. A number of models attempt to do just that. The best known of these "heat balance" type models are those developed by the U.S. Army Corps of Engineers (USACE,1956) after extensive research in the 1950's. Similar work was also carried out in the Soviet Union in the 1960's (Kuz'min,1970).

These models tend to be quite complex, although simplified versions of the U.S. Army Corps models do exist. The parameters of these "heat balance" type models are chosen from the following list of factors which affect melt rate:

air temperature
snow surface temperature
per unit cloud cover
cloud base temperature
insolation (sunlight)
long wave radiation
sublimation heat loss
condensation heat gain
vapour pressure gradient and/or relative humidity
wind speed
snow surface albedo (reflectivity)
snow surface emmissivity

In spite of the seeming simplicity of the theory, only the coefficients for insolation and long wave radiation have been derived theoretically. The rest of the coefficients have been fitted empirically using regression (USACE, 1957; Kuz'min, 1970)

An example of such a model is Kuz'min's heat balance equation shown below:

$$\text{DAILY MELT DEPTH} = 0.12\,(\text{INS}\,(1-\text{ALBEDO}) - 1.18\,E{-}7 \times TS^{4} + 1440\,(0.62+0.25\sqrt{e}) \times (1+0.12CT+0.12CL) \times 8.18\,E{-}11 \times TA^{4}) + A \times GAMMA \times V$$

where DAILY MELT DEPTH = mm
INS = insolation (ly/day)
CT = total cloud cover (per unit)
CL = low cloud cover (per unit)
TA = air temperature (°K)
TS = snow surface temperature (°K)
e = vapour pressure at 1 meter above snow (mb)
V = wind speed at 1 meter above snow
GAMMA = (TA-TS) + 1.75(e-6.11)
A = 0.878(1+0.547V)/V
ALBEDO = snow surface albedo (per unit)

Studies to test the applicability of these snowmelt models to Arctic conditions were carried out in the North West Territories at Snowbird Creek, Bathurst Island. The studies were part of an intensive basin water budget study by the Water Survey of Canada (Wedel et al, 1977). An extensive set of hydrometeorologic observations were taken, including snow surveys. Analysis of the data showed that the models of the USACE and Kuz'min do not work well when transferred to the Arctic. In particular their predictions of the effects the effects of insolation and the loss due to sublimation are poor.

An examination of the work of both the U.S. Army Corps of Engineers and Kuz'min shows that it was assumed that all the energy of the solar radiation absorbed by the snowpack would cause either heating or melting of the snow (melting occurs when the temperature of the snow is already at 0 C). It was felt that the portion of this energy that would instead cause sublimation was negligible, and that sublimation could be accounted for by condidering only vapour pressure gradient and wind turbulence. Studies at Snowbird Creek indicated that the amount of sublimation is greater than can be explained in this way and that in fact a significant portion of the absorbed solar radiation causes sublimation rather than melting. This hypothesis is supported the

observation from quantum physics that the photon energy of sunlight is on the average approximately ten times the energy required to cause the sublimation of snow. It therefore seems reasonable that some of the energy due to insolation should cause increased sublimation rather than melting. Another observation at Snowbird Creek was that the cost of collecting all the data data needed for fitting and using "heat balance" type models was extremely high, and it is felt that the expense is not warranted by the quality of the results. It was concluded that a more simple type of model should be sought.

Another commonly used type of model is the so called 'black box' or empirical model. These are frequently simple regression equations, typically including only a few of the parameters listed for the heat balance models. Air temperature, insolation, and wind speed are most often used (Davar,1970;USACE,1959) These models have the practical advantage of being easy to fit. They require much less data in order to be calibrated to a specific region, and statistical fit to the data is frequently almost as good as that from the heat balance models.

An example of such a simple model is one fitted to data from Snowbird Creek (Wedel et al,1977) :

$$\text{DAILY MELT DEPTH} = 3.17T_A + 3.49$$

(for temperatures over 0 celsius)

where MELT DEPTH = mm
T_A = air temperature (°C)

A number of recent developments in the field of stochastic (statistical) time series analysis appear to be applicable to the study of snowmelt. To insure that the best possible stochastic model is obtained, it is recommended that three distinct stages in model development be followed (Box & Jenkins,1970). The first stage is the identification, using appropriate statistical tools, of the type of model which may best fit the data. The next stage is to estimate the model parameters using maximum likelihood estimation. Finally, diagnostic checks are used to insure that any assumptions made in the previous two steps are not violated and that the model adequately fits the data. If the model does not pass the diagnostic checks, then stages one and two are repeated using different parameters or perhaps using some suitable transformation on the data. This process is continued until an adequate model is found. Improvements in the statistical tools used in the three stages of model development, and new computer programs to facilitate the actual computations (Hipel et al,1977;McLeod et al,1977) have made this process of model development relatively straight-forward.

Significant advances have been made in the use of stochastic models in such diverse areas as hydrologic simulation and intervention analysis (Hipel et al,1975). Hydrologic simulations are used in the planning and operation of water resources systems. Intervention analysis, a stochastic modelling technique which statistically quantifies the effect of a natural or man-induced intervention on a time series, promises to be useful in the assessment of environmental impact. Also of interest are the Box-Jenkins type of transfer function models. These models may be useful in the implicit modelling of snowmelt. The exact form of transfer function which will be most appropriate has not yet been worked out. It is expected that models linking, say, runoff time series to precipitation and temperature, will soon be available.

A number of different types of model have been discussed in this paper, and the list is by no means exhaustive. Clearly a very large number of possibilities exist, as the relevant parameters can be put together in a great many combinations, and an unlimited number of transformations may be applied. A method is needed to choose between competing models.

One such method suggested in the recent statistical literature is the use of the Akaike Information Criterion (Akaike,1974), or AIC. The first application of this criterion to the stochastic modelling of water resources was in Canada at the University of Waterloo (Hipel et al,1975). The Akaike Information Criterion, based on developments in information theory, is defined by:

$$AIC = -(2 \times \ln ML) + 2k$$

where ML = maximum likelihood
k = the number of model parameters

The statistical goodness of fit is considered in the ML term, and the practical consideration that a model with few parameters is computationally efficient and easy to work with is considered in the +2k term. The model with the lowest AIC is chosen as the best model. Thus a means that does not depend on the bias of the individual researcher is available for choosing between models.

IV Conclusions & Recommendations

1) Currently available data on depth and density of snow in the North is not well suited to use in hydrologic studies. It is suggested that if more suitable data is to be obtained a program of snow surveys be carried out especially for this purpose by the Inland Waters Directorate.

2) A number of snowmelt models are currently available, and new models are under development. It is suggested that in the North simple "black box" type of models be fitted to study basins as needed on an individual basis. The Akaike Information Criterion, or some similar criterion which considers both goodness of statistical fit and simplicity of the model, can be used in choosing among the different models.

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Session 10B

SIMULATION OF RUNOFF, FALLS RIVER, ELLESMERE ISLAND, NORTHWEST TERRITORIES

D.C. Ambler

Session 10B

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INTRODUCTION

The opportunity to investigate the surface water runoff from a particular area on Ellesmere Island, Northwest Territories, was first presented to the Inland Waters Directorate (Atlantic Region) in early 1973. The Frozen Sea Research Group, Fisheries and Marine Service, Department of Environment, had for some years been conducting oceanographic research in d'Iberville Fiord, Ellesmere Island. It became obvious, at that time, that accurate estimates of freshwater runoff into the fiord were required. The modelling of fiord water circulation required both the magnitude and timing of freshwater inflows from around the fiord. The Inland Waters Directorate (Atlantic Region) had also at that time, early 1973, been operating a hydrometric station in southern Baffin Island known as Sylvia Grinnell River near Frobisher Bay (10TE001).

The fiord, an extension of Greely Fiord, is located in the northern portion of Ellesmere Island. D'Iberville Fiord extends from 78° west to 80° west at a latitude of about 80° 30' north. Figure 1 illustrates d'Iberville Fiord and its surrounding drainage patterns. The north side is unglaciated and forms a peninsula separating it from the northeast side of Greely Fiord. The southern side is steep with a glacier flowing in from the south. Climatically, the area experiences long, cold winters from 9 to 10 months with temperatures lowering to -30°C. The short summers of approximately 3 months bring warming temperatures up to 10-15°C. The mean annual precipitation estimated to be 140 mm is anticipated to fall 50% as rain during June, July and August.

The 1973 field trip to d'Iberville Fiord began with reconnaissance surveys for sites having good hydraulic properties for the establishment of hydrometric stations.

A control or representative basin was to be instrumented along with other less instrumented basins. The basin decided upon for intense monitoring was named Falls River. This basin is highlighted in Figure 1. The choice was based on availability of a good discharge metering site and proximity to the Research Group camp. Other basins were instrumented in 1974 with water level staffs and time-lapse cameras. The monitoring of runoff was also done using fluorescent tracer dyes.

The Falls River Basin has an area of 29.5 km^2 (11.4 square miles), and a perimeter of 30 km (18.6 miles). The mean channel slope is near 5% except for a falls 9-12 metres (30-40 feet) near the basin mouth. The basin is not glaciated. Figure 2 illustrates the relief of the Falls River Watershed.

The Inland Waters Directorate, Atlantic, experience in 1973 was also expanding in southern Baffin Island. Hydrometric sites were established on the Apex River at Apex (10TE002), Duval River near Pangnirtung (10TE003), and on Broughton Island on the Tulugak River near Broughton (10TE004). The Falls River station operated until 1975. The stations at Apex, Pangnirtung and Broughton are continuing seasonal stations.

The Inland Waters Directorate experience within the Atlantic Region, since 1973, has included detailed work on the application of the Streamflow Synthesis and Reservoir Routing (SSARR) Model to the flow regime of the Saint John River Basin in New Brunswick. The continuation of this work is now formalized within the Canada-New Brunswick Agreement on Flood Damage Reduction.

OBJECTIVES

The simulation of runoff from both snowmelt and rainfall, on the Falls River Watershed, addresses a number of questions. The suitability of applying a physically based parametric mathematical model, such as SSARR, to simulate runoff in a region of continuous permafrost is a priority question. Application of a model of this type is dependent upon the availability of meteorologic, hydrologic and physiographic data. An assessment of data requirements is a direct spinoff of this application. This in turn leads to discussing the data collection programs themselves. The value of this trial, should it prove acceptable, will grow during repeated use. Establishing relationships among the various elements of the hydrologic cucle will assist in transposing data to ungauged watersheds. Assessing the impact on the environment of proposed or existing developments is a high priority. Having simulation data or the capability of transposing observed data will assist impact assessment procedures and the evaluation of assessments done by other organizations.

MODEL APPLICATION

The Streamflow Synthesis and Reservoir Regulation (SSARR) Model is a mathematical hydrologic model of a river basin system. The model is built on three components. These are:

1. A generalized watershed model;
2. a river system model;
3. a reservoir regulation model.

In this particular application, only the watershed portion of the model is used. The success of simulating is dependent upon the development of various parameter relationships. The watershed characteristics are determined by trial and error iterations to simulate historical stream-flow data. An independent data set is required for validation. No validation runs were made in this application. Figure 3 presents a flow chart of the major watershed model parameters. The model data require-ments are summarized into four types:

1. Non-variable data such as drainage area, elevation area relationships, storage capacities, etc.

2. Initial conditions data such as streamflow, snowpack depth, soil moisture index, etc.
3. Time variable data such as precipitation, air temperature, snowmelt, etc.
4. Computer job control cards.

Within the watershed, the following elements of the hydrologic cycle are accounted for.

1. Net basin precipitation
2. Soil moisture
3. Evapotranspiration loss
4. Runoff excess
5. Surface storage
6. Sub-surface storage
7. Groundwater storage
8. Flow separation among soil zones.

The temperature-index snowmelt option requiring daily temperature data from at least one station of known elevation and a specified melt rate is applied throughout. The snowpack characteristics are simulated using the snow-band option. This option is used because it maintains an inventory of snow-water equivalent for each compute period. The reader is referred to the *Program Description and User Manual* for further details on these options and the other routines available in the SSARR Model.

The application of this model requires many variables to be specified prior to beginning calibration runs. The variables and their final values after calibration are listed below.

Variable	Established Value
Watershed Routing Parameters:	
Surface	7 phases @ 12 hours
Sub-surface	5 phases @ 24 hours
Baseflow	1 phase @ 999 hours

Variable	Established Value
Baseflow Infiltration Index:	
Time of storage	30 hours
Rain-freeze temperature	34°F
Base temperature	35°F
Temperature lapse rate	3.3°F/1000 feet
Soil moisture index	3.00 inches

The input data were collected and processed in English units. The SSARR Model output is also in English units. Whenever possible, results and other quantities are expressed in S.I. units.

SIMULATION RESULTS

The simulation of watershed runoff, assuming adequate input data are available, is dependent upon the establishment of relationships between certain parameters. The following relationships are established:

1.	Runoff Percent	=	f (Soil Moisture Index)
2.	Surface Infiltration	=	f (Surface and Sub-surface Infiltration Rate)
3.			
3.	Baseflow Percent	=	f (Baseflow Infiltration Index)
4.	Evapotranspiration Index	=	f (Calendar Month)
5.	Effectiveness of ETI	=	f (Rate of Precipitation)
6.	Daily Distribution of Precipitation	=	f (Time of day)
7.	Daily Distribution of Snowmelt	=	f (Time of day)
8.	Elevation	=	F (Area of watershed below that of elevation)

The verification of this simulation on an independent data set is not done. All three data sets are used for the calibration procedure.

A simple water balance is used to qualify the simulations. This balance considers the known water equivalent in the snow pack just as melting begins and any moisture that occurred during the simulation period. Moisture loss during the simulation period is estimated by the Evapotranspiration Index. Table 1 lists the balance items. A daily comparison of observed and simulated mean daily runoff is presented for each year in Tables 2, 3 and 4.

DISCUSSION

Upon inspection of the simulation results it is quickly seen that poor resemblance to observed information at times exists. Trial and error calibration procedures can continue only until certain limits are attained. Some of these limits include simulation results within an established error range and insignificant changes in results due to parameter changes. The runoff simulations, herein, did not reach an acceptable overall resemblance to observed data. Further changes to parameter values were not continued as some values were becoming unrealistic. The poor simulation has a number of error sources. The input data, including collection and processing methods, no doubt include errors. It is assumed, herein, that the snow-water equivalent is evenly distributed over the basin. This is not in reality true. On-site observations noted initial snow-free areas and long-lasting snow in depressions. The starting snow-water equivalents are increased by 20%, and all precipitation amounts are increased by 10%. Precipitation catch deficiencies of 10% are not uncommon (AES personnel communication), and measured snow depths in northern areas have been noted to be in error up to 35% (Finlay 1966). On the other hand, snow storage in a northern basin has been found to be about twice the amount recorded by a climatological station. (Woo and Marsh, 1977). The use of a single station time series of mean daily temperatures also has error potential. Chyurlia (1976) found that the mean air temperature did not explain runoff production very adequately. On-site experience proves that the temperature immediately above the ground is not the same as the mean air temperature. The 24-hour incoming solar radiation produces warm surface temperatures. The progression of snowmelt is controlled more by this surface temperature than by the mean air temperature. Also, the use of a daily temperature rather than hourly temperature does not allow the model to "see" the diurnal fluctuations.

A major parameter relationship in the SSARR watershed simulation model is the variation of direct surface runoff with changes in the soil moisture content. At the beginning of snowmelt the surface is totally frozen. As melt progresses the active layer develops. The d'Iberville Fiord area soils are classified as "polar desert". Soils of this type range from poorly drained mineral soils to quickly drying gravels. This range is evident in the Falls River watershed. The Soil Moisture Index in this application is started at about 77 mm (3 inches). The value maintained a high percent of direct runoff during snowmelt and was depleted quickly after the snow pack vanished. Chyurlia (1976) found the soil moisture to increase by about 7% each day until all melt had occurred. Although permafrost is assumed to be a moisture-impermeable material leaving only surface and active layer hydrology, a routing phase for groundwater was included. This was an effort to maintain low flows after snowmelt ceased and between rain events.

"We particularly need models for cold regions which have a basis closely related to sound physical fundamentals and which are simple because of the extreme lack of verifying data" (Carlson, 1974). This quotation quickly suggests the direction of research needs in support of cold regions hydrology. The watershed simulation option of the SSARR model is relatively simple and is physically based. Using only the temperature-index snowmelt routine, the data needs are reduced to a low level. The input data and verification data needs are trailing model requirements. An identifiable need is for jointly-planned data collection programs by the Inland Waters Directorate and the Atmospheric Environment Service. In general terms, the climatic hydrologic characteristics of northern Canada are known. More detailed information on snowmelt and surface temperature, infiltration rates and soil moisture is required even for this relatively simply physically based model. Research is required into the recognition of parameter specific homogeneous areas. Operational requirements could be better defined and operational data applied in a less site-specific manner. The parameter relationships established in this calibration are largely linear interpolations between estimated co-ordinates. The functional relationship, in greater detail, is required for runoff as a function of soil moisture and infiltration particular to Polar and Sub-Polar Desert type soils.

Reflecting upon the objectives of this paper, it may be concluded that the watershed option of the SSARR model is suitable for simulating runoff in a region of continuous permafrost.

Specific parameter relationships were not established; however, the general interactions are known. The data required and available were found to be again adequate but not in the detail necessary. Simulating a daily event requires knowledge of events within the day. Good potential is seen for use of this type of model in preparing and assessing environmental impact statements.

TABLE 1

WATER BALANCE VERIFICATION

YEAR	SNOW MELT EQUIVALENT AT BEGINNING OF MELT mm(inches)	MOISTURE INPUT DURING MELT mm(inches)	TOTAL MOISTURE INPUT mm(inches)	ESTIMATED EVAPOTRANSPIRATION LOSS mm(inches)	MOISTURE AVAILABLE FOR RUNOFF, STORAGE AND INFILTRATION mm(inches)	OBSERVED RUNOFF mm(inches)	SIMULATED RUNOFF mm(inches)
1973	74(2.90)	12(0.47)	86(3.37)	35(1.38)	51(1.99)	67(2.64)	79(3.13)
1974	35(1.37)	24(0.94)	59(2.31)	50(1.77)	9(0.54)	90(3.55)	45(1.77)
1975	32(1.25)	6(0.25)	38(1.50)	21(0.84)	17(0.66)	29(1.12)	35(1.36)

TABLE 2

SIMULATION RESULTS
(1973)

DATE	MEAN DAILY OBSERVED RUNOFF (cfs)	MEAN DAILY SIMULATED RUNOFF (cfs)	DIFFERENCE (cfs)
June 11	0	1	+1
12	0	4	+4
13	0	5	+5
14	0	4	+4
15	0	2	+2
16	0	2	+2
17	0	4	+4
18	2	13	+11
19	4	36	+32
20	9	78	+69
21	41	124	+83
22	89	147	+58
23	98	135	+37
24	100	114	+14
25	126	96	-30
26	98	72	-26
27	50	51	+1
28	30	34	+4
29	26	20	-6
30	19	9	-10
July 1	20	4	-16
2	18	2	-16
3	18	1	-17
4	20	1	-19
5	23	0	-23
6	17	0	-17
TOTALS	808	959.	+151

TABLE 3

SIMULATION RESULTS
(1974)

DATE	MEAN DAILY OBSERVED RUNOFF (cfs)	MEAN DAILY SIMULATED RUNOFF (cfs)	DIFFERENCE (cfs)
June 23	0	1	+1
24	0	11	+11
25	0	35	+35
26	0	54	+54
27	0	53	+53
28	0	38	+38
29	0	22	+22
30	105	11	+94
July 1	85	8	-73
2	58	13	-45
3	63	23	-40
4	54	29	-25
5	49	38	-11
6	56	54	-2
7	62	53	-9
8	55	35	-20
9	31	20	-11
10	35	13	-22
11	25	11	-14
12	46	7	-39
13	75	4	-71
14	72	2	-70
15	48	1	-47
16	36	1	-35
17	43	0	-43
18	61	1	-60
19	30	4	-26
TOTALS	1089	542	-506

TABLE 4

SIMULATION RESULTS
(1975)

DATE	MEAN DAILY OBSERVED RUNOFF (cfs)	MEAN DAILY SIMULATED RUNOFF (cfs)	DIFFERENCE (cfs)
June 6	0	1	+1
7	0	4	+4
8	7	30	+23
9	88	77	-11
10	46	93	+47
11	18	71	+53
12	18	42	+24
13	29	23	-6
14	32	16	-16
15	27	15	-12
16	11	15	+4
17	11	11	0
18	11	8	-3
19	15	6	-9
20	17	4	-13
21	14	2	-12
TOTALS	344	418	+74

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Session 11

IWD DATA AND CONSULTANTS

Carson Templeton

Session 11

IWD DATA AND CONSULTANTS

by

Carson Templeton

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Chairman, Alaska Highway Pipeline Panel

You have asked me, I think, to state what the consultant wants from the IWD so that he can make an environmental impact assessment. A consultant's reaction might well be, "I want everything -- stage discharge curves, flood frequencies, sediment load, color, PH; in fact, all of the water quality standards, plus the characteristics of the soil particles in the channel and floodplain -- and I want it for every stream that my project might affect."

By saying this, the consultant makes two assumptions -- first, that he is not going to have to pay for the information, and second, that the quality of the report will be judged by the amount of data he can provide. The fact that the data may or may not be relevant to the conclusion the report has reached often has nothing to do with the case. Engineers' jobs are quite often defined as requiring that their projects are adequate and economic. The impact assessment process is now asking some project developers and their

engineers to consider the protection of the environment and of the social fabric as well. This is a radical change and is not universally accepted either by engineers or their employers. The Government of Canada requires some industries, but not all, to make an environment impact assessment; others to do environmental and social impact assessments. However, if the developer is government itself, these assessments are not required. An example of this can be found in the fact that the pipelines from the western Arctic have been subjected to fairly rigorous examination for environmental and social impacts, while the Mackenzie and Dempster Highways have not.

Obviously, the place of impact assessments has not been clearly established at this time; but I think it is reasonable to accept the principle that conservation of the environment and of the social fabric should be taken into account in making public policy decisions. If you can accept that, then it follows that we should try to optimize the process -- to make it faster, more economical, and more specific and pertinent to the decision at hand.

I think the reason for making the assessments, or predictions, is to tell the decision makers what they can expect if a development goes ahead. Impact assessments should not be limited to developments. Other actions such as laws, regulations, and, in fact, all activities that will change the natural environment and social fabric, should go through some

sort of technical review process so that an opinion can be made regarding the significance of the impact. But at the present time, in Canada, only developments are considered; so I will comment only on them. A prudent person does not dive into strange waters without having a thought about the risks and consequences. The decision maker owes it to the country to put his reasoning on paper, in a public place, so that others can know why he made the decision he did. There is no place for secret cabinet documents in the impact assessment process.

One cannot make an impact assessment unless one considers alternatives, including the "no-go" option. Without that, the author is merely legitimizing a development. All of this process leads up to the prediction of impacts so that the decision maker, if he can and will read, makes an informed decision.

The process breaks down because many people consider that the impact assessment process is an end in itself. But it's only Phase One, and an understanding of the next three phases is important if Phase One is to be successful.

Phase Two is setting out the Terms and Conditions. When you make an impact assessment, you make certain assumptions as to what the developer will and will not do if the development goes ahead. In addition, you have to assume that

certain controls and restrictions will be imposed on the developer. Unless these are detailed, your predictions may well be invalid.

Phase Three is the monitoring and surveillance. Its objective is to see that the developer actually does what the Terms and Conditions and commitments require him to do.

Phase Four is the post-operative evaluation. Its purpose is to see what lessons could be learned from the project by posing such questions as: How accurate were the predictions? How effective were the terms and conditions and surveillance activities in protecting the environment?

All four phases should apply to any developer whether he is in the public or the private sector. The reasoning that the Mackenzie and Dempster Highways should not be subjected to an Impact Assessment Review because they were built by the Federal Government, is irresponsible. A bulldozer and its operator are the same if they work for a government department or work for an oil Company; furthermore, the damage to the environment is the same. A highway has many times the impact of a gas pipeline in the long term. As far as I know, DPW has never made an Environmental Impact Assessment and subjected it to independent review.

Now, to get back to the Impact Assessments and the data that a consultant needs.

Well, in the first place, the people who make the assessment should demonstrate the need for the collection of new data. I think that all existing data on the environment should be available to the public; when it comes to the collection of new data, then the need should be demonstrated. You can well ask the question: How important will the data be in the ultimate decision? There is no doubt that all data are useful, but much data collected for a development are often short term and they will not contribute much to long-term data base of the resource. In the Mackenzie Valley pipeline impact assessment, literally hundreds of pounds of basic research material were produced. The applicant said it cost $200 million to collect. But even if the actual research cost $30 million, it is still a lot of money. Some said it was the most thoroughly researched project in the history of Canada. Although the data were very valuable to Canada in the long run, much of it did not contribute much to the prediction of impacts of the project. The mental jump between raw data and an impact prediction was more than most of us could make.

Engineers and scientists collected basic data on such things as population counts of animals, water flow, measurements for a day or month, or crime statistics. But what do these data mean and how do you convert them into impact pre-

dictions? Much of the data collected for the Mackenzie Valley Gas Pipeline Project were not converted.

On the route across the Mackenzie Delta, the pipeline company's scientists and engineers presented their data and drew a conclusion that this route was superior to a route around the Delta, and was acceptable environmentally. I drew the exact opposite conclusion on the same data. To have opposite opinions on such an important issue, indicates that the data presented on both sides allowed only subjective opinions.

The Water component in Phase 1, The Impact Assessment phase, of the western Arctic gas pipeline was mainly concerned with impacts on fish habitat, water quality and terrain degradation. Fish habitat included siltation of spawning beds, reduction of sunlight due to sediment load, interference of migrations, and destruction of overwintering pools. Water quality was concerned about the addition of toxic wastes from the testing of the pipeline, from camps, and from accidental oil spills at construction staging depots. Terrain degradation involved erosion, change of surface or subsurface migration of water, and aesthetics.

But rather than going into the details of the data needed to analyze these impacts, I would prefer to put them into the context of how the data will be used and their im-

portance in the ultimate decision.

I should repeat that we are talking about the Impact Assessment phase, not the Terms and Conditions Phase. In my opinion, there is no need to collect masses of data for the prediction of impact of a project if it is not going to be used in making the decision. Some people argue that more data are needed for the Terms and Conditions phase. However, my experience is that every project gets revised in scope, location, time of the year of construction, and type of construction before it goes ahead, so why collect information until you have a fairly complete knowledge of the project description?

Now let me discuss the evolution of impact assessments, using the example of the national decision to build a western Arctic gas pipeline. Let me also talk about the relative importance of the water data in that national decision. Don't feel badly if water is not the most important concern (if it were an oil pipeline, things would be different). It is the significance of the issues that is important. The decision will not be based on a long list of concerns. It will be boiled down to four or five issues. Therefore, the final package presented to a decision maker should be simple; its recommendations should be based on the most significant four or five impacts.

The "handout" illustrates the water concerns in one project, primarily erosion and siltation, in a number of reports. We looked at these aspectes in a macro sense and not at precise values. The first page delineates aspects of the aquatic physical environment that would be affected by the Mackenzie Gas Pipeline, Alaska to Alberta. The second page shows the concerns regarding "Water" addressed in the Initial Environmental Evaluation of the Proposed Alaska Highway Gas Pipeline, Yukon Territory. Different conditions prevailed in the Alaska Highway case, as opposed to the Mackenzie case -- less permafrost, silt-laden rivers, not as many problems with frost heave with an unchilled pipeline. In the second study, we outline the concerns in the physical environment. This proved to be difficult since perceived impacts inter-related with other environmental classes such as the biological and the human ones.

We came to the conclusion, since months before the pipeline debate, that there would be two different route proposals. Although we never had any illusions that a comparison would not be a subjective one, we attempted to devise a means by which the two different projects would be evaluated numerically, and, therefore, compared. We provided a subjective opinion of relative importance, using a scale from one to five, as shown on page three. There were many problems with this approach, stemming mainly from its subjectivity. However, this appeared to be the only way of at-

tempting to provide a comparison, considering the short time frame within which we had to work.

On page four, a physical environment comparison shows relative values in a similar way. Our findings were 2:1 in favouring the Alaska Highway pipeline. Had we had to present these findings in hearings, no doubt we would have been severely challenged.

The fifth page illustrates the relative importance of key issues in the 1977 pipeline decision. This evaluation reflects my personal biases. It shows four main pieces in the decision process: national economy, project, policy, and environment. For example, out of 1,000 points, I assigned 300 to environment; in that 300, the human issues were the predominant concerns. The applicants, of course, focussed their discussion in the project issues.

It is evident that there are many problems with this analysis. Water concerns were worth only 25 points out of 1,000 in the national decision. However, at the terms and conditions stage, this could well change. Plotting the methodology of the national decision would save much time and put the emphasis on these aspects that will contribute the most to that decision. When it comes to writing the terms and conditions, and outlining the methods of monitoring and surveillance, more information will be needed.

In the decision making process, we must all get away from our own narrow, specialized view, for fear that nobody will look at the overall picture. This is perhaps the fault of the whole system: society is so complex now that it's very difficult to look at the whole picture. We must convince the people that advise governments of the need to present the relative importance of various issues. The adoption of such a policy would assist decision makers in understanding the critical issues and, thereby, making a more informed decision and that really is the purpose of the impact assessment process.

CHAPTER 7
MACKENZIE GAS PIPELINE, ALASKA TO ALBERTA EFFECTS ON THE AQUATIC PHYSICAL ENVIRONMENT

C.D.D. HOWARD

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Howard, C.D.D. 1974. Mackenzie gas pipeline, Alaska to Alberta — Effects on the aquatic physical environment. Pages 177-202 *in* Research Reports, Vol. IV *of* Environmental impact assessment of the portion of the Mackenzie gas pipeline from Alaska to Alberta. Environment Protection Board, Winnipeg, Manitoba.

ABSTRACT

A hydrological analysis of climatological, topographical, and geological data was used to estimate flood frequencies and suspended sediment concentrations before and after construction, and to classify all streams according to their hydrological behaviour. Qualitative descriptions of stream behaviour including the potential for winter aquatic habitat in streams, were also developed.

It was found that the greatest potential for measurable increases in suspended sediment concentrations is on the few small, steep watersheds having a large fraction of the drainage area disrupted by airstrips, quarries and compressor sites, in addition to road and pipeline rights-of-way. The greatest potential for major interference with natural stream processes is on the Yukon coast where large in-stream gravel borrow operations have been suggested by the Applicant. Unless the quantities of gravel to be removed are a small fraction of the annual volume transported by the source stream, such operations should be avoided.

INTRODUCTION

The water resources of the regions crossed by the pipeline are subject to the effects of construction and operation through interference with natural land drainage, changes in river regime and suspended sediment concentration, and other water quality indicators. Definition of the potential importance of these physical effects provides background understanding for assessments of the biological implications of the pipeline activity. Additionally, the water resource has value for its own sake and is an environmental feature which can be overly exploited by careless development. Understanding the physical behaviour of the waters crossed by the pipeline, and of areas which provide nearby alternative habitat, was the goal of the present studies.

If adequate streamflow data were available, it would have been summarized in some convenient form directly from the records. However, most of the streams crossed by the pipeline have never been gauged. In the absence of such data, a theoretical approach was taken to describe the physical setting of bodies of water influenced by the pipeline. This approach used the statistics of climatological events, measured topographical features, and available data describing surficial geology. The

INITIAL ENVIRONMENTAL EVALUATION OF THE PROPOSED

ALASKA HIGHWAY GAS PIPELINE, YUKON TERRITORY

WATER

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Adam, K. and A. Permut. 1977. Water. Pages 43-121 in Initial environmental evaluation of the proposed Alaska Highway gas pipeline, Yukon Territory. Alaska Highway Pipeline Panel, Winnipeg. 691pp.

The potential to affect fewer groundwater users during construction is an advantage for the Arctic Gas route. But this is offset by its potential to disrupt more subsurface drainage during operation. Thus, there is no preference (5:5) for either route on the basis of the groundwater regime.

The following table summarizes our comparison of the two routes for the water component of the physical environment.

Table 6. Water component of the physical environment comparison summary.

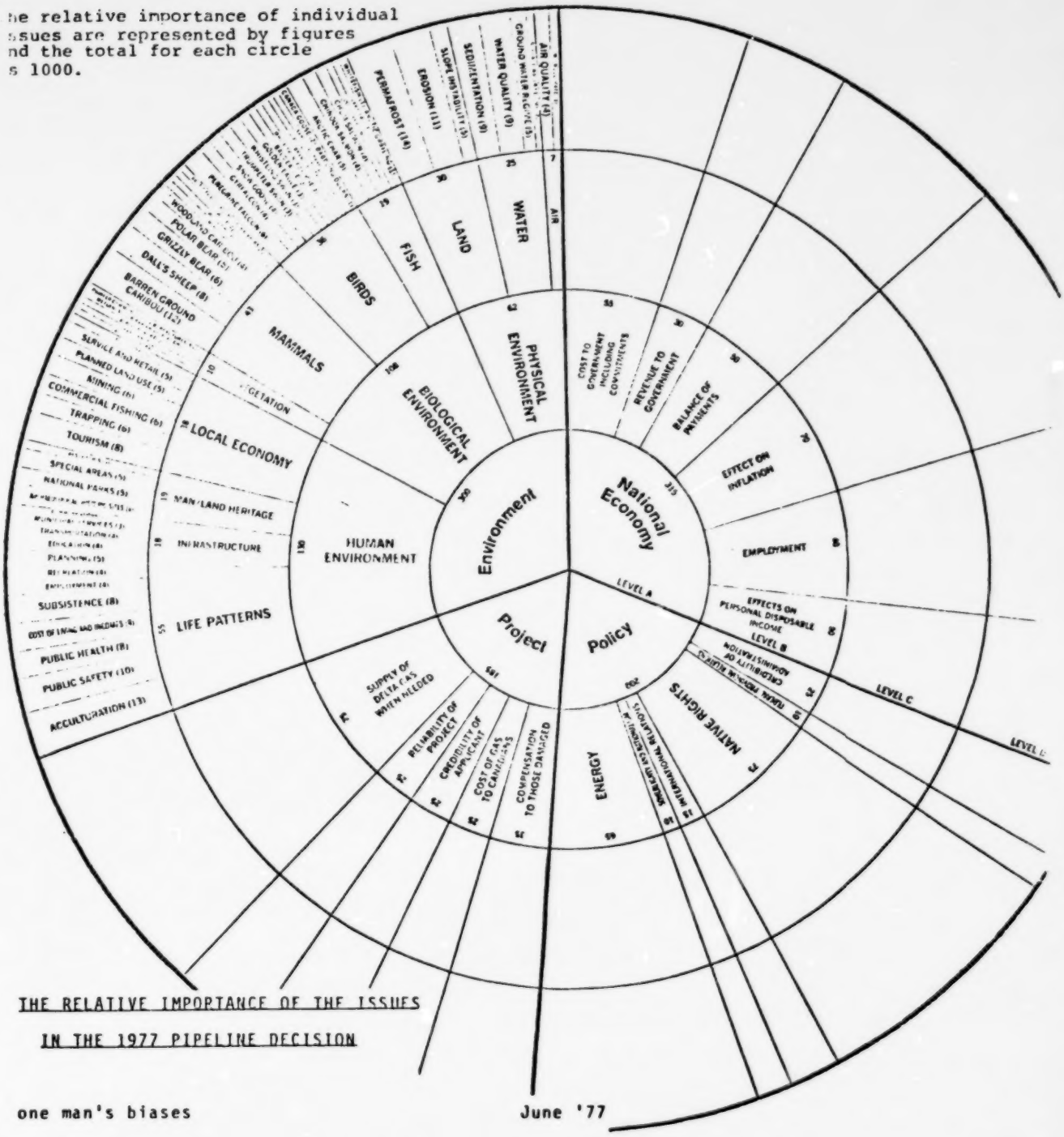
	Relative Importance Weighting	Relative Preference		Weighted Preference	
		Alaska Highway	Arctic Gas	Alaska Highway	Arctic Gas
WATER COMPONENT					
Sedimentation	30	5	3	150	90
Water quality	30	5	2	150	60
Groundwater regime	16	5	5	80	80
Surface water regime	8	5	2	40	16
	84			420	246
Preference Ratio				1.7	1.0

In terms of the water component, the Alaska Highway pipeline is preferred over the Arctic Gas pipeline by 1.7:1.

Table 8. Physical environment comparison summary.

	Relative Importance Weighting	Relative Preference		Weighted Preference	
		Alaska Highway	Arctic Gas	Alaska Highway	Arctic Gas
LAND COMPONENT					
Permafrost	47	5	1	235	47
Erosion	37	5	2	185	74
Slope stability	15	5	5	75	75
Total	99			495	196
Preference ratio				2.5	1.0
WATER COMPONENT					
Sedimentation	30	5	3	150	90
Water quality	30	5	2	150	60
Groundwater regime	16	5	5	80	80
Surface water regime	8	5	2	40	16
Total	84			420	246
Preference ratio				1.7	1.0
AIR COMPONENT					
Air quality	12	5	4	60	48
Microclimate	11	5	2	55	22
Total	23			115	70
Preference ratio				1.6	1.0
PHYSICAL ENVIRONMENT					
Total				1030	512
Preference ratio				2.0	1.0
OTHER FACTORS					
Seismic risk		2	5		
Frost heave		5	1		
Climatic influence on construction		5	3		
Winter roads		5	2		

he relative importance of individual
ssues are represented by figures
nd the total for each circle
s 1000.



THE RELATIVE IMPORTANCE OF THE ISSUES

IN THE 1977 PIPELINE DECISION

one man's biases

June '77

IT'S THE WEIGHT OF THE RAW DATA, NOT THE USE OF IT, THAT IS NEEDED TO SUPPORT MY REPORT THAT THE IMPACTS WILL BE NEGLIGIBLE.

Session 12

BRIEF OUTLINE of FEARO PRESENTATION

Session 12

BRIEF OUTLINE of FEARO PRESENTATION

to

I.W.D. WORKSHOP - WINNIPEG, Oct 31 to Nov 2, 1978

Topic Suggested

EAR Process, to be discussed in such a way as to include:

- Information requirements, how they are determined, and how they are assigned to I.W.D.
- How information required is included in environmental impact statements.
- The effectiveness of I.W.D. in this regard.

Also to be addressed:

- Lessons learned to date.
- How environmental impact assessment procedures could be improved.

Plan

I plan to explore these questions within the following topic headings:

1. The EAR Process
   - to be discused from a transparency of the process diagram.
2. Where information requirements are generated within the process (process diagram slide).
3. Role distinction.
   - EARP
   - PANEL
   - FEAR OFFICE
   - D.O.E.
4. Roles of D.O.E. (I.W.D.) staff in process.
   - transparency of a matrix giving interaction.

   If time is short, this can be a handout before questions begin

FUNCTION	Initiator	ROLE			
		Individual Tech. (Expert)	Task Force	Unit of Dept.	Dept.
A. GENERAL					
Tech. Expert	O.G.D's	X		X	
	RSCC	X	(X)		
	FEAR OFFICE	(X)			
Guideline Preparation	PANEL (FEARO)	X	X		
Panel Member	PANEL (FEARO- DM)	X			
Info & Advice	D.M.	X		X	(X)
	O.G.D's	X	X		(X)
	RSCC	X	X		(X)
	FEAR OFFICE	(X)			(X)
Intervenor	DM/ADM			(X)	X
E.I.S. Comment	Panel (FEARO)			X	X
Baseline Data	D.M. O.G.D's		X	X	X
Advisor to Min.					
B. SPECIFIC					
Surveillance					
Monitoring					

Session 13

RATIONALIZATION OF CURRENT DATA COLLECTION PROGRAMS AND PROCEDURES AND NEW REQUIREMENTS FOR ENVIRONMENTAL IMPACT ASSESSMENT

SESSION 13

RATIONALIZATION OF CURRENT DATA COLLECTION PROGRAMS AND PROCEDURES AND NEW REQUIREMENTS FOR ENVIRONMENTAL IMPACT ASSESSMENT

To this point in the workshop we have been examining the experiences of IWD staff and discussing the performance of the IWD agencies. We must realistically assess the IWD organizational procedures, and if necessary, the mandates also to ensure that our efforts are relevant.

What is the real value of these short-term studies? Many of the observations/findings from this type of study have been documented elsewhere. One year's data of hydro-meteorological results has some value. Is the cost justified?

More work is required on:

- scour problems.

- morphologic responses of rivers to their imposed hydrologic regime.

- sediment transport of coarse grain materials.

- unstable channel hydraulics and geometry.

The basic, fundamental problems deserve greater study.

River modifications (crossings, berms, dredging, etc.) should be made only after potential environmental impacts have been outlined and evaluated. An inventory of existing environmental resources (social, economic and natural) is mandatory.

– areas of unique vegetation, wildlife and aquatic life – endangered or threatened species.

Ecological studies are necessary to document the present characteristics of the environment, to estimate the effects development will have and to provide the basis for selecting measures for minimizing any projected adverse effects.

It is essential to combine and coordinate ecological studies with those developed for evaluating engineering needs.

How can our existing operational and research agencies execute their responsibilities and if necessary, modify or change them to meet the needs of environmental assessments?

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LISTE DES PARTICIPANTS

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ENVIRONMENTAL IMPACT ASSESSMENT IN THE NORTH

Oct 31, Nov 1 - 2, 1978

Winnipeg, Manitoba

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